NOTE: 400 pts from
SOIL LOCATIONS!
EFAC RUNS 23.3
KM FROM LAKE REALITY

DOE/OR/02-1370&D1

Record of Decision
for
Lower East Fork Poplar Creek

DOE/OR/02-1370&D1

Record of Decision
for
Lower East Fork Poplar Creek

Date Issued—May 1995

Prepared by
Jacobs ER Team
125 Broadway Avenue
Oak Ridge, Tennessee
under contract DE-AC05-93OR22028

Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management

PREFACE

This record of decision for Lower East Fork Poplar Creek (EFPC) (DOE/OR/02-1370&D1) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act to present the selected remedy to the public. This work was performed under work breakdown structure 1.4.12.3.1.04 (Activity Data Sheet 9304, "Lower East Fork Poplar Creek"). (Publication of this document meets a Federal Facility Agreement milestone of June 1, 1995.) This document provides the Environmental Restoration Program with information about the selected remedy for Lower EFPC, which involves excavating floodplain soil with mercury concentrations > 400 parts per million and disposing of the soil at a landfill at the U.S. Department of Energy—Oak Ridge Y-12 Plant. Information in this document summarizes information from the remedial investigation (DOE/OR/02-1119&D2&V1 and V2), the feasibility study (DOE/OR/02-1185&D2&V1 and V2), and the proposed plan (DOE/OR/02-1209&D3).

ACKNOWLEDGEMENTS

This document was prepared by the Jacobs ER Team under prime contract to the U.S. Department of Energy. Team members are:

Jacobs Engineering Group Inc.
Geraghty & Miller, Inc.
Lockwood Greene Technologies, Inc.
PAI Corporation
Solutions To Environmental Problems
United Science Industries
University of Tennessee

Additional support was given to the team by Martin Marietta Energy Systems, Inc.

ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
cm	centimeter
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
EFPC	East Fork Poplar Creek
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FFA	Federal Facility Agreement
ft	foot
g	gram
ha	hectare
in.	inch
kg	kilogram
km	kilometer
lb	pound
LOAEL	Lowest Observed Adverse Effect Level
m	meter
mg	milligram
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
OREPA	Oak Ridge Environmental Peace Alliance
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	operable unit
oz.	ounce
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppm	parts per million
RfD	reference dose
RGO	remediation goal option
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act of 1986
TDEC	Tennessee Department of Environment and Conservation
Y-12 Plant	Oak Ridge Y-12 Plant
yd	yard

PART 1. DECLARATION

SITE NAME AND LOCATION

U.S. Department of Energy
Lower East Fork Poplar Creek Operable Unit
Oak Ridge Reservation
Oak Ridge, Tennessee

STATEMENT OF BASIS AND PURPOSE

This record of decision (ROD) presents the selected remedial action for Lower East Fork Poplar Creek (EFPC) in Oak Ridge, Tennessee. The action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 *United States Code* Section 9601 *et seq.* and, to the extent practicable, the National Oil and Hazardous Substance Contingency Plan.

This decision is based on the administrative record for Lower EFPC, including the remedial investigation report (DOE 1994a), the baseline risk assessment, the feasibility study report (DOE 1994b), the addendum to the remedial investigation (DOE 1994c) that includes the sediment toxicity special study, the proposed plan (DOE 1995b), and other documents contained in the administrative record file for this site.

This document is issued by the U.S. Department of Energy (DOE), as the lead agency. The U.S. Environmental Protection Agency (EPA) and Tennessee Department of Environment and Conservation (TDEC) are supportive agencies as parties of the Federal Facility Agreement (FFA) for this response action, and they concur with the selected remedy.

ASSESSMENT OF THE SITE

If releases of hazardous substances from this site are not addressed, they present an unacceptable risk to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This response action fits into the overall Oak Ridge Reservation (ORR) cleanup strategy by addressing floodplain soil, sediment, and groundwater contaminated by mercury originating from the DOE Oak Ridge Y-12 Plant (Y-12 Plant). Remediation of the surface water in Lower EFPC can best be accomplished through the DOE Y-12 Environmental Restoration Program, and the continuing mercury releases will be regulated under the Clean Water Act National Pollutant Discharge Elimination System permit for the Y-12 Plant. Therefore, Lower EFPC surface water is not within the scope of this ROD, but is discussed for informational purposes only. The objective of this remedial action is to minimize the risk to human health and the environment from mercury-contaminated soil and sediment in the Lower EFPC floodplain pursuant to CERCLA and the FFA (1992).

The selected remedy addresses the principal threats at the site by excavating and disposing of the identified floodplain soils contaminated above the remediation goal of 400 ppm mercury. The major components of the selected remedy include:

- excavating identified floodplain soils with mercury concentrations greater than 400 ppm from four areas. [Three of the areas are at the National Oceanic and Atmospheric Administration (NOAA) site (two areas in Parcels #571 and one area in #461), and the other area is at the Bruner's Center site (Parcel #564). The total in situ volume to be excavated is estimated to be 7,650 m^3 (10,000 yd^3)];

- disposing of the contaminated soil in a permitted landfill at the Y-12 Plant;

- performing confirmatory sampling in the excavated areas to ensure all mercury concentrations above 400 ppm have been removed;

- backfilling the excavated areas, including the 0.24-ha (0.6-acre) wetland at the Bruner's Center, with clean borrow soil and vegetating appropriately; and

- appropriate monitoring on Lower EFPC to ensure effectiveness of the remediation.

Groundwater does not present an unacceptable risk to human health and the environment. If sufficient quantities of groundwater could be extracted from the shallow soil horizon (0–20 ft) for residential use, such groundwater could pose an unacceptable risk. However, because residential use of the shallow soil horizon (shallow) groundwater is not realistic (as explained in

more detail in the Decision Summary), groundwater is not considered an unacceptable risk. As a safeguard, DOE will monitor to detect any future residential use of the shallow groundwater. In the unlikely event such use is detected, DOE will mitigate, as appropriate, any risks associated with such use.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate, and is cost-effective. However, because treatment of the soils, which pose the principal threat at the site, was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. This remedy will result in remediation of hazardous substances that allows for unlimited use of, and unrestricted exposure to, the Lower EFPC OU.

APPROVALS

_____ _____

Manager
U.S. Department of Energy
Oak Ridge Field Office

Date

_____ _____

Director, DOE Oversight Division
State of Tennessee
Tennessee Department of Environment and Conservation

Date

_____ _____

Regional Administrator
U.S. Environmental Protection Agency
Region IV

Date

PART 2. DECISION SUMMARY

SITE LOCATION AND DESCRIPTION

ORR is located in Oak Ridge, Tennessee, approximately 32 km (20 miles) west of Knoxville, Tennessee. The Y-12 Plant is located on 324 ha (800 acres) in Bear Creek Valley, 3.2 km (2 miles) south of downtown Oak Ridge.

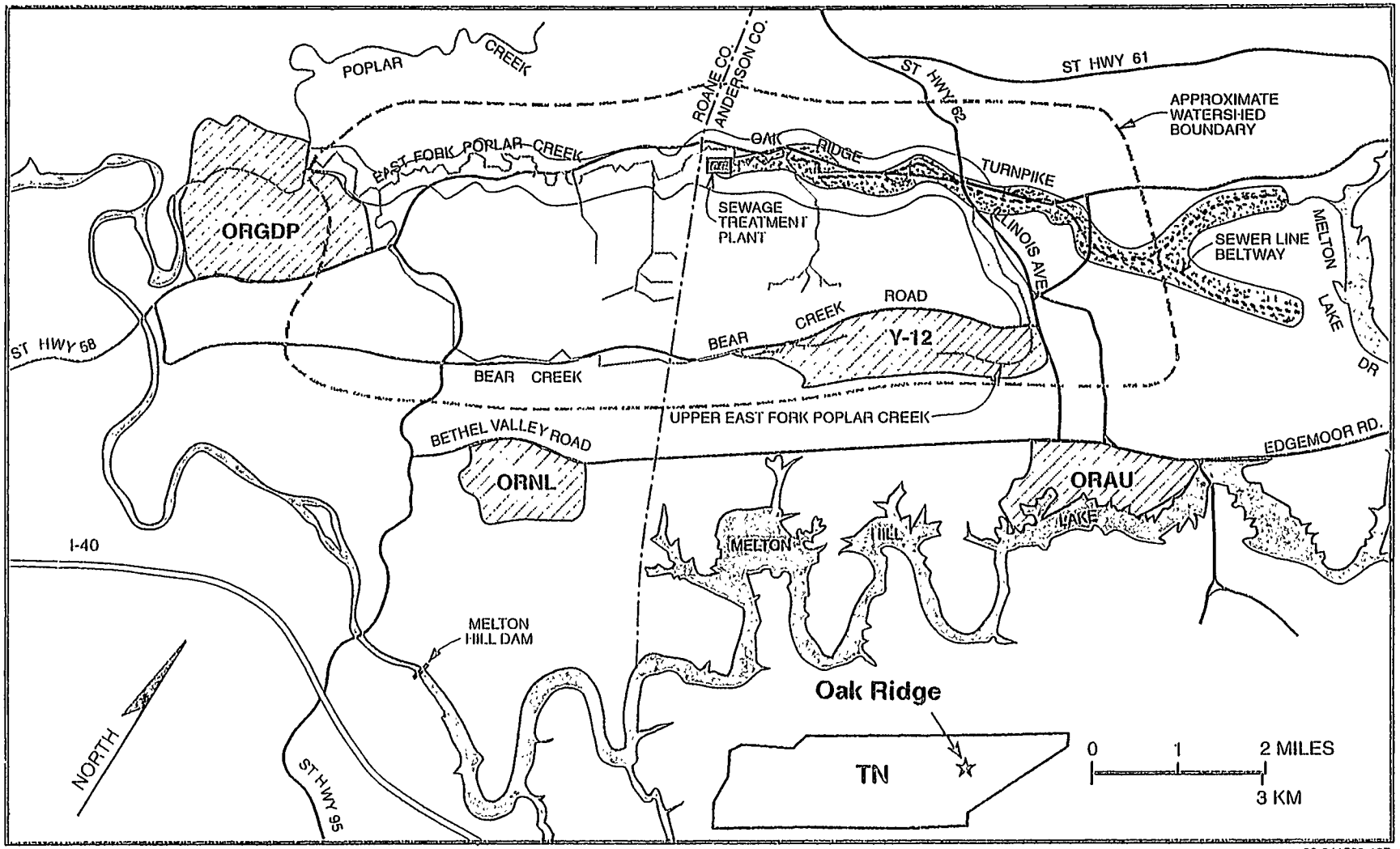
The Lower EFPC Operable Unit (OU) site includes the soil, sediment, and groundwater in the 100-year floodplain along Lower EFPC and the Sewer Line Beltway (Fig. 2.1). More than 20 tributaries and treated effluent from the Oak Ridge Sewage Treatment Plant flow into the creek. EFPC begins within the Y-12 Plant as the Upper EFPC. Upper EFPC is a separate OU with contamination and is addressed independently of this action. The Upper EFPC OU terminates at Lake Reality, a retention pond at the eastern end of the Y-12 Plant.

The Lower EFPC OU begins at the outfall of Lake Reality and ends at its confluence with Poplar Creek 23.3 km (14.5 miles) downstream. In addition, floodplain soils from Lower EFPC served as backfill material for construction of the Sewer Line Beltway through the city of Oak Ridge, and these soils have been included as part of the investigation. The site includes portions of ORR and commercial, residential, agricultural, and miscellaneous areas within the city of Oak Ridge (see "Scope and Role of OU" for descriptions of the various remedial units). Some residences are within 400 m (.25 miles) of the areas to be remediated.

SITE HISTORY AND ENFORCEMENT ACTIVITIES

Between 1953 and 1983, operation of the lithium isotope separation processes at Y-12 resulted in the release of 108,000 to 212,000 kg (239,000 to 470,000 lb) of mercury into Lower EFPC. Although the primary mercury loss from the Y-12 Plant stopped in 1963, mercury continues to be released into Lower EFPC from secondary sources (e.g., building drain systems, sewers, and connecting lines) at the plant. The current release averages approximately 20 g/day (0.7 oz./day), down from 100 g/day (3.5 oz./day) in 1985. Portions of the sewers were relined in 1986-1987 to reduce mercury losses. Efforts continue to further reduce mercury losses (e.g., decontamination and decommissioning, reduction of mercury in plant effluents, and remediation of mercury-use areas) with a goal of meeting the requirements of the Draft National Pollutant Discharge Elimination System permit.

The state of Tennessee posted advisory signs warning the public that Lower EFPC was contaminated. In 1989, ORR was placed on the National Priorities List (NPL) as a CERCLA



LEGEND

EFPC floodplain

Sewer Line Beltway

Fig. 2.1. Location map for Lower EFPC.

site requiring investigation. Areas of the EFPC OU that have been contaminated by DOE releases of hazardous substances are also considered part of the NPL site. With respect to EFPC soils, the release (or site) is limited to areas within the 100-year floodplain and does not extend to areas outside the floodplain, with the exception of soils that may have been taken from the floodplain and used in other areas as fill (e.g. Sewer Line Beltway). (A more detailed description of the release is provided in the remedial investigation/feasibility study.)

In accordance with CERCLA and as agreed to in the FFA (DOE 1992) by DOE, EPA, and TDEC, a remedial investigation (DOE 1994a) and a feasibility study (DOE 1994b) were conducted, and a proposed plan (DOE 1995b) was developed. This ROD fulfills the next requirement of the CERCLA process. It presents the selected remedial action for Lower EFPC, chosen in accordance with CERCLA, as amended by SARA and, to the extent practicable, the National Oil and Hazardous Substance Contingency Plan. The decision for this site is based on the information contained in the administrative record file.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

Public involvement has been an important element throughout the Lower EFPC project. In the early stages of the project, DOE conducted numerous meetings with property owners who lived along the creek to inform them of sampling and other activities associated with the remedial investigation.

At a public meeting held by DOE in March 1993, the remedial investigation and preliminary feasibility study were presented. DOE answered many questions and comments from the public at that point. One outcome of the meeting was the formation of a citizens working group of about 30 members of the public to provide feedback to DOE and its contractors during preparation and selection of potential remedial action alternatives. From the outset, DOE explained that the group was not a decision-making or consensus-building group. DOE is responsible for recommending the preferred cleanup alternative to EPA and TDEC. All three agencies must also agree on the final cleanup action.

Between May 1993 and November 1994, 12 meetings were held with the citizens group members to provide them with information to better understand the cleanup process. Meeting discussions focused on issues involved in conducting the remedial investigation and the feasibility study; building blocks of the site-wide cleanup alternatives; institutional actions; ideal

characteristics of a remedial action; the risk assessment process; mercury-reduction efforts at the Y-12 Plant; and mercury speciation. The group also toured areas of the creek that contained the highest levels of mercury.

Members of the citizens working group played an active role throughout the entire decision-making process and especially during the official public involvement period. They submitted articles to the local newspapers, sent comments to DOE, and encouraged other members of the community to become involved.

DOE believes input from the citizens group has been invaluable to the project team in understanding the community concerns and opinions of the project.

In addition to the citizens group, DOE has provided fact sheets and updated them on a regular basis; published numerous articles in a widely distributed newsletter; issued media releases; contacted local media about meetings dealing with Lower EFPC issues; and produced a video that helped citizens understand more about potential cleanup alternatives for the floodplain soils.

In the summer of 1994, the Lower EFPC team participated in DOE's Speakers Bureau to generate awareness of the project among community and civic organizations. As a result, the team spoke to eight organizations where approximately 260 people learned more about the project.

The public also had the opportunity to receive all the documents leading up to DOE's selection of the preferred alternative [the remedial investigation (DOE 1994a), the feasibility study (DOE 1994b), and the proposed plan (DOE 1995b)]. A document request form was sent to more than 1,500 stakeholders, with more than 100 people requesting and receiving documents.

DOE placed numerous announcements in area newspapers and on local television and radio to prepare for the official public comment period. The public comment period was January 9, 1995, through February 22, 1995. DOE formally presented the preferred alternative at the public meeting January 26, 1994. Approximately 50 comments were received during the meeting, 9 of which were submitted anonymously. DOE received approximately 40 letters during the public comment period. Responses to the summarized comments received are included in this ROD as Part 3, "Responsiveness Summary."

SCOPE AND ROLE OF OU

The Lower EFPC OU encompasses soil, sediment, and groundwater contaminated with mercury downstream from Lake Reality at the Y-12 Plant to the confluence of Poplar Creek. Because topographic ridges separate the site from the other DOE ORR plants, only waterborne contaminants carried by EFPC from the Y-12 Plant affect the site. The remedial action for the Lower EFPC site fits into the overall cleanup strategy for ORR by addressing this downstream contamination. Remediation of the surface water in Lower EFPC can only be accomplished through the DOE Y-12 Plant Environmental Restoration Program. Direct discharges from the Y-12 Plant are regulated under the Clean Water Act National Pollutant Discharge Elimination System permit for the Y-12 Plant. Therefore, the surface water remediation is not within the scope of this project, but is discussed for informational purposes only. Investigation of Upper EFPC and other OUs addresses contamination within and adjacent to the Y-12 Plant and on the rest of ORR.

SUMMARY OF SITE CHARACTERISTICS

The Lower EFPC site includes two distinct but overlapping areas—Lower EFPC and the Sewer Line Beltway. Lower EFPC flows 23.3 km (14.5 miles) from Lake Reality at the Y-12 Plant to its confluence with Poplar Creek near the Oak Ridge K-25 Site (see Fig. 2.1). The site includes creek sediment and soils making up the creek's 100-year floodplain. The Sewer Line Beltway consists of 16 km (10 miles) of sewer lines with one portion within the floodplain of Lower EFPC and two branches in the city of Oak Ridge. Because Sewer Line Beltway soils present no significant risk, the beltway is not discussed further.

Lower EFPC is a perennial stream flowing through Anderson and Roane Counties in Oak Ridge, Tennessee. The creek's watershed (approximately 77.2 km^2/29.8 $miles^2$) consists of many streams and tributaries that flow into EFPC. This watershed lies primarily within East Fork Valley and is bounded by Black Oak Ridge on the northwest and East Fork Ridge on the southeast.

A range of soils makes up the 270-ha (670-acre) floodplain of Lower EFPC and is mostly well-drained and somewhat acidic. All are classified as prime farmland. Much of the land in the floodplain is already in or committed to urban development or water storage.

Surface water flow leaving the Y-12 Plant contains spring water, surface drainage water, and a relatively large amount of Y-12 Plant discharge water. This flow averages 0.24 m^3/second (8.6 ft^3/second) and is augmented downstream by additional groundwater discharge, stormwater and stormflow, and the discharge of the Oak Ridge Sewage Treatment Plant. Some contaminants are present in surface water during baseflow conditions. Stormflow exhibits higher concentrations of various metals, indicating they are particle-bound.

Results from the first phase of the soil, sediment, groundwater, and surface water sampling in the remedial investigation showed detectable levels of 13 heavy metals, 9 polycyclic aromatic hydrocarbons (PAHs), 2 polychlorinated biphenyls (PCBs), and 11 radionuclides.

For the heavy metals, mercury was by far the most significant contributor with >85 percent of the total toxicity. For radionuclides, total uranium accounted for 98 percent of the total activity. The organic compound groups of PAHs and PCBs did not substantially contribute to the estimated risks to human health. Risk associated with exposure to radionuclides fell within the EPA acceptable target range in all cases. The results of the baseline human health risk assessment confirmed mercury as the predominant contaminant of concern in Lower EFPC.

Groundwater flow in the floodplain is predominantly through a fairly shallow "stormflow zone" immediately beneath the land surface. Enhanced hydraulic conductivity in this zone results from a widespread system of small cavities caused by roots, worms, and burrowing animals. In addition, the shallow or alluvial aquifer (composed of stream sediments) reaches 6 m (20 ft) in thickness. Water levels fluctuate in the alluvial aquifer, reflecting evapotranspiration and the aquifer's hydraulic communication with Lower EFPC. East Fork Valley is predominantly developed in limestone bedrock. Some evidence for relatively deep along-strike groundwater flow exists; however, bedrock is unlikely to provide much water to the creek. Even if the creek loses water to the bedrock aquifer, the mercury contamination is predominantly particle-bound, and the low-velocity flow in the bedrock would not transport these particles. In addition to mercury, groundwater samples showed elevated naturally occurring metals, primarily particle-bound and not available for transport through the aquifer. No active potable water wells are located within the floodplain, and groundwater is currently not a drinking water source.

Ecological resources potentially impacted by remedial activities include aquatic and terrestrial habitats, animals, and plants. Surface water and sediments are two primary abiotic components of aquatic habitats and are the major exposure pathways for contaminants. These habitats occupy a total of about 21 ha (52 acres). Riparian habitats (habitats near a stream) include the stream channel, banks, and floodplain spanning the transition from aquatic to terrestrial habitats and communities. Many organisms present in the creek use both communities

in the course of their lives. For example, many insects have aquatic larval stages, but terrestrial adult stages. Riparian habitats are fairly narrow along the creek, ranging from 10 to 30 m (11 to 33 yd) wide of contiguous floodplain vegetation or land-use type parallel to the creek. Disturbance of riparian habitats often has direct negative effects on the wide range of biota that use this habitat.

An analysis of species richness or diversity in aquatic biota can serve as an indicator of water quality. A 1991 fish population survey in Lower EFPC, using Hinds Creek as a control, found taxonomic richness and diversity were depressed near the Y-12 Plant and increased further downstream, probably as a result of the reduction in toxicant concentrations downstream. Species tolerant of contamination predominated near the Y-12 Plant, supporting this conclusion. In general, many taxa exhibited decreased diversity all along Lower EFPC as compared to the control site.

Exposure of terrestrial plants and animals to contaminants in soil and attendant vegetation varies according to feeding habits. For the evaluation of ecological risk, three terrestrial cover types were defined: urban, forest, and field. These were further divided into more specific subelements. In terms of these subelements, the majority of terrestrial habitats are bottomland hardwoods. The only significant and systematic variation in terrestrial biota was an increase in the mean number of flying insect populations downstream. There was also an increase in the mean number of aquatic insect larvae downstream. In general, biological diversity increased with distance from the Y-12 Plant.

The U.S. Army Corps of Engineers defines wetlands as swamps, marshes, bogs, and similar areas having wetland hydrology, hydrophytic vegetation, and hydric soils. A floodplain and wetlands assessment [Appendix J of the feasibility study (DOE 1994b)] and floodplain statement of findings [Appendix K of the feasibility study (DOE 1994b)] were prepared for Lower EFPC. Seventeen jurisdictional wetland areas were identified, comprising approximately 4.9 ha (12 acres). Most of these wetlands provide highly productive wildlife habitat. Studies undertaken in conjunction with the investigation of the Lower EFPC show that mercury is being accumulated by wetland animals at concentrations comparable to levels found in other animals in other nonwetland areas of the floodplain and that some of this mercury occurs as methylmercury in crayfish. Only 0.24 ha (0.6 acres) of one jurisdictional wetland area will be affected by implementation of the selected remedy.

Although potential habitat may be available along the Lower EFPC floodplain, there is no documentation of the presence of any federally listed or state-listed threatened or endangered

species. The remedial investigation (DOE 1994a) and the feasibility study (DOE 1994b) list the threatened and endangered species that have been reported in Oak Ridge and the surrounding area.

An archaeological reconnaissance of the Lower EFPC area identified six historic period sites, two prehistoric sites, and a steel truss bridge. The identified archaeological sites will not be affected by remediation of the floodplain soils.

The area that Lower EFPC flows through hosts a range of human activities and land uses. For the purposes of the site investigation, these uses were grouped into five categories: residential, commercial, agricultural, other, and DOE-owned. These categories, or remedial units, are described in the "Scope and Role of OU" section. Households within 150 m (500 ft) of the creek with an associated population of 1,189 are potentially most affected by the contamination. These residents live in clusters near the intersection of Oak Ridge Turnpike and Illinois Avenue, and also in west Oak Ridge near Bruner's Center. These areas are shown in the "Selected Remedy" section.

Contamination of the Lower EFPC can be understood through a conceptual model for contaminant transport. The initial premise is that soil contamination in the floodplain is closely linked to hydrologic events. Contaminants from the Y-12 Plant were washed down Lower EFPC during high-flow conditions following rain storms. At least some contaminants were adsorbed onto sediment particles and were transported downstream in a suspended phase. Other contaminants were transported in dissolved phase. During flood events, the creek overflows its banks and spreads out across its floodplain, depositing contaminated sediments on vegetation and the land. Considering this model, the remedial investigation focused on the evaluation of surface water, creek sediments, floodplain soils, and groundwater as potentially affected media. The remedial investigation identified a wide range of contaminants of potential concern (DOE 1994a).

Mercury concentrations in Lower EFPC decrease with distance downstream from the Y-12 Plant, although above-background concentrations occur at depositional areas (i.e., where the water flow slows down, such as through braided areas) throughout the floodplain. In general, however, mercury and other inorganic constituents are situated in defined areas of the floodplain and not randomly scattered throughout its length.

Creek sediments contain the same constituents as floodplain soils, but at lower concentrations. Because of the transient nature of sediments, the distribution of metals is not as predictable in sediments as it is in soils. The upper reaches generally show somewhat elevated levels of the various metals compared to the lower sections of the creek.

SUMMARY OF SITE RISKS

Baseline human health and ecological risk assessments were conducted as part of the remedial investigation (DOE 1994a) to examine the potential for adverse health effects in humans and ecological receptors from exposure to chemicals released from the Y-12 Plant to Lower EFPC. The results of the baseline risk assessment were used to determine the need for remediation. The baseline risk assessment was, therefore, an evaluation of potential risks in the absence of remedial action.

HUMAN HEALTH RISKS

The baseline human health risk assessment used a "tiered" or phased approach. In Tier I, contaminate data from locations of highest projected concentration were screened against toxicity data to identify chemicals of potential concern. The second phase (Tier II) was the full baseline evaluation using a comprehensive data set and a thorough assessment of current and future land uses. Tier III was a probabilistic risk assessment. In this approach, called Monte Carlo simulation, input parameters are defined as ranges or distributions. The result of this simulation is a distribution of risk estimates from which the probability of individual values can be determined. This is used to help understand and quantify the uncertainty inherent in the results of the baseline risk assessment.

The EFPC floodplain was divided along the length of the creek into nine segments for the purposes of data aggregation and risk assessment. These segments were based on an understanding of the nature and extent of contamination and a knowledge of current and projected future land uses. Inorganic and organic chemicals and radionuclides were identified as chemicals of potential concern based on the concentration-toxicity screen (Tier I) evaluation. These substances were carried through the full baseline human health risk assessment (Tier II). Sampling data from EFPC were aggregated so that exposure point concentrations could be calculated separately for each land-use area within each segment.

The exposure scenarios were based on land-use type: (1) agricultural setting, (2) residential populations, (3) commercial setting, and (4) occasional use of open land. The receptor groups at greatest risk of exposure were assumed to be children and adults who reside in the vicinity of EFPC. For each exposure scenario and receptor group, the intensity, duration, and frequency of exposure were characterized. Exposure pathways include the following:

- incidental ingestion of soil;

- dermal exposure to soil;
- dermal exposure to surface water while swimming and wading;
- incidental ingestion of surface water while swimming;
- dermal exposure to sediments while wading;
- ingestion of groundwater as a drinking water source and inhalation of groundwater vapors during showering;
- ingestion of homegrown produce, beef, and dairy;
- ingestion of recreationally caught fish; and
- inhalation of particulates while mowing.

The exposure evaluations were based on reasonable maximum exposure assumptions as requested by EPA Region IV. The reasonable maximum exposure estimate is a "high end" conservative estimate of exposure in the population at potential risk. In addition to reasonable maximum exposure point estimates, probability simulations were used to generate a range of exposure and risk estimates (Tier III) that were used in uncertainty analysis and as a supplement to the single-point reasonable maximum exposure estimate.

Noncarcinogenic and carcinogenic effects of exposure to contaminants in EFPC were evaluated in the risk assessment. Toxicity measures needed to evaluate these effects were selected for chemical compounds and radionuclides and include: (1) reference doses for oral exposure — acceptable intake values for chronic and subchronic exposure (noncarcinogenic effects), (2) reference concentrations for inhalation exposure—acceptable intake values for subchronic and chronic exposure (noncarcinogenic effects), (3) cancer slope factors for oral exposure, and (4) cancer slope factors for the inhalation route.

EPA had withdrawn the oral reference dose for mercury from the Integrated Risk Information System data base (EPA 1993). A reference dose (0.0003 mg/kg/day) obtained from the EPA Health Effects Assessment Summary Tables [HEAST Fiscal Year 1993-94 (EPA 1992a)] was used in the baseline human health risk assessment. This reference dose was based on toxicity testing using soluble mercury species (mercuric chloride) in laboratory animals, not the less

soluble forms (mercuric sulfide and elemental mercury) that were shown to predominate in EFPC floodplain soils. The baseline risk assessment, therefore, conservatively assumed that all mercury in EFPC is present in its most toxic and bioavailable form.

Risk characterization was conducted using reasonable maximum exposure assumptions. This approach resulted in high end (i.e., protective) estimates of the potential for adverse noncarcinogenic and carcinogenic effects associated with long-term exposure to contaminants in EFPC. For noncarcinogenic effects, risk estimates were determined to be of concern (i.e., exceeding the target range established by EPA) if the hazard quotient for any given chemical or the hazard index for combined exposure across chemicals exceeds 1. Estimates of excess lifetime cancer risk that exceed 1×10^{-4} were determined to be of concern (i.e., fall outside the target range of 1×10^{-6} to 1×10^{-4} established by EPA for waste site remediation under the CERCLA program).

Groundwater does not present an unacceptable risk to human health and the environment. In the RI, risk estimates for the groundwater ingestion pathway were based on data from the soil horizon (0–20 ft deep) and exceeded the acceptable EPA target range. These risk estimates considered all conceivable uses of the groundwater regardless of probability, including residential use. Residential use of groundwater from the soil horizon, however, is unrealistic because of insufficient yield, the availability of municipal water supply, and legal restriction on drilling water supply wells less than 20 ft in depth. (The only calculated risk greater than EPA's protective range associated with other groundwater horizons was related to manganese levels, which are naturally occurring and not the result of a release). Accordingly, groundwater is not considered to present an unacceptable risk and remediation goal options for groundwater were not carried over into the analysis of alternatives in the FS or this ROD.

Results of the baseline human health risk assessment indicate unacceptable risks to human health (i.e., exceed the target ranges established by EPA under the CERCLA program for waste site remediation) may result from exposure to the Lower EFPC floodplain soils. Three exposure pathways of concern were identified: (1) direct contact with soils, (2) ingestion of groundwater as a drinking water source, and (3) ingestion of produce and beef raised in the floodplain.

Risk estimates based on reasonable maximum exposure assumptions indicate the potential for adverse health effects associated with long-term exposure to EFPC soils. Children ages 3 to 12 years were identified as the receptor group at greatest risk. Mercury was identified as the predominant contaminant of concern and inadvertent soil ingestion to be the exposure pathway of greatest significance. Remaining toxicity due to other contaminants present will be reduced

by the remedial action. Organic chemicals observed in EFPC media did not substantially contribute to the estimated risks to human health. Risks associated with exposure to radionuclides fell within the EPA acceptable target range in all cases.

Risk assessment of contaminant transfer from soils to food in the agricultural pathways resulted in estimates that exceed the EPA target ranges. These exposure pathways, while included for completeness in the study, may overestimate contaminant uptake. The uncertainty analysis conducted as part of the baseline risk assessment indicates substantial uncertainty and conservatism associated with the soil-to-tissue biotransfer factors. Available monitoring data indicated low levels of contaminants in plant and animal tissue samples, and these did not correlate with projected (i.e., modeled) concentrations using biotransfer factors.

The results of the baseline human health risk assessment confirmed mercury as the contaminant of concern in EFPC and direct exposure to soils as the critical exposure pathway. Remediation goals were derived for mercury in EFPC soils.

Evaluation of risk presented in the feasibility study focused on mercury as the single contaminant of concern in floodplain soils and direct soil contact as the exposure pathway of concern (DOE 1994b). The remediation goal was developed to protect the most sensitive receptors (i.e., children) following long-term, inadvertent ingestion exposure and dermal contact with soils containing mercury.

Results of mercury speciation and leaching/availability studies (DOE 1994c) on EFPC soils indicated that the less mobile and less bioavailable forms of mercury predominate in EFPC floodplain soils. The remediation goal is based on the presence of mercuric sulfide and metallic mercury rather than mercuric chloride (i.e., the mercury species upon which the mercury reference dose was based). The remediation goal was derived as a conservative, risk-based value (point estimate), following EPA methods. In addition to the point estimate, a quantitative uncertainty analysis was conducted to examine the uncertainty surrounding the remediation goal and the assumptions that form the basis of this estimate.

ECOLOGICAL RISKS

The ecological risk assessment followed EPA's *Framework for Ecological Risk Assessment* (EPA 1992b), which includes problem formulation, analysis (exposure characterization and effects characterization), and risk characterization. Assessment and measurement endpoints were defined and used in the assessment. Approved protocols were followed to select and measure abundance, diversity, taxonomic richness, and contaminant body burdens at various trophic levels in aquatic

organisms (fish and benthic macroinvertebrates) and terrestrial organisms (small mammals, birds, earthworms, insects, and vegetation). Organisms were analyzed to determine the whole-body concentrations of inorganic chemicals, PAHs, pesticides, and PCBs.

Surface water, sediment, and floodplain soils were evaluated as potential sources of contaminant risk to nonhuman receptors. Inorganics, PCBs, and chlordane as a representative of pesticides, and PAHs were retained as contaminants of potential concern for plants and animals.

Consumption of contaminated organisms provides risk to both aquatic and terrestrial predators. Historical and current studies of bioaccumulation showed (1) higher body burdens of contaminants in common stonerollers, redbreast sunfish, crayfish, earthworms, and terrestrial insects at EFPC sites than at uncontaminated reference sites; and (2) generally decreasing body burdens with increasing distance downstream from the Y-12 Plant. A notable exception is that redbreast sunfish had higher PCB and pesticide body burdens at some sites distant from the Y-12 Plant than at the site closest to the Y-12 Plant. Based on tree ring analysis, the trunks of trees showed elevated mercury levels that probably reflect exposures three to four decades ago. Elevated contaminant body burdens were also noted in terrestrial mid-level predators (shrews and wrens), reflecting current exposures. Generally, elevated contaminant levels were not observed in plant leaves or in white-footed mice, which consume both plants and terrestrial insects.

No threatened or endangered species nor critical habitats for them were found in the EFPC floodplain. Therefore, the remedial investigation concluded that there is no current threat from contaminants in the EFPC floodplain to threatened or endangered species or their critical habitats (DOE 1994a).

The remedial investigation (DOE 1994a) concluded that there is ongoing risk to ecological resources, especially aquatic organisms in the upper part of the creek, from exposure to contaminants in environmental media and food. Mercury was the primary contaminant of concern in the sediments and floodplain soils. PCBs were a contaminant of concern associated with biota. The source of the PCBs appears to be associated with the Upper EFPC OU and will be evaluated as part of the Y-12 Plant Environmental Restoration Program. Direct contact with and ingestion of surface water, sediment, and sediment pore water are primary exposure pathways for aquatic organisms. The food chain is also a primary exposure pathway for aquatic fauna. Releases from the Y-12 Plant are the primary source of waterborne contaminants; however, evidence suggests that some ecological recovery of the aquatic community has been occurring in

the upper reaches of the creek, as documented by the Y-12 Plant Biological Monitoring and Abatement Program (Loar et al. 1992; Hinzman et al. 1993). Nevertheless, elevated contaminant body burdens and an excess of pollution-tolerant species are still present.

Toxicity studies (DOE 1994c) showed no toxicity to test organisms from chemicals extracted when sediment was suspended in water. Sediment-based food chain exposures were also evaluated (DOE 1995). Exposures from EFPC sediments are substantially lower than those from surface water. EFPC sediments do not currently pose a risk to aquatic organisms nor their predators.

The food chain is the most important exposure pathway for terrestrial organisms. Initial results in the remedial investigation report (DOE 1994a) indicated that there were potential risks to terrestrial organisms. Additional studies were done to determine the relationship of apparent risks to soil mercury concentrations (DOE 1994c). These studies included analysis of organisms exposed in wetlands and expanded analysis of mercury content in vegetation. The studies concluded that there is no threat to plant communities from mercury in floodplain soils. Mercury concentrations in some floodplain soils are a potential threat to biota by exposure through the food chain.

Ecologically based RGOs were derived by evaluating several exposure scenarios. Site-specific data, exposure assumptions, and toxicity thresholds were evaluated further to determine what soil concentrations could protect biota.

DESCRIPTION OF ALTERNATIVES

Remedial alternatives evaluated in the feasibility study (DOE 1994b) spanned a wide range of cleanup options for Lower EFPC. Table 2.1 summarizes the impacts of each of the alternatives. In all cases, best management practices would be followed to control fugitive dust, surface water and rain runon and runoff, erosion, and to minimize the area disturbed. Alternative 3 is the selected remedy and is discussed in more detail in the "Selected Remedy" section.

ALTERNATIVE 1: NO ACTION

CERCLA requires that the no action alternative be evaluated at every site to establish a baseline for comparison. Under this alternative, no further action would be taken at the site to

Table 2.1. Summary of impacts due to Lower EFPC remedial alternatives

Impact	Alternative						
	1	2	3	4	5	6	7
1993 Cost ($ million)	12	23-50	22-48	26-57	26-55	22-47	18-39
Volume excavated (m^3)	0	7,103	7,646	7,103	7,646	0	2,329
Area impacted (hectare)	0	2.47	2.47	2.47	2.47	2.79	1.85
Wetlands area impacted (hectare)	0	0.25	0.25	0.25	0.25	0.25	0.25
Time to complete (weeks)	0	62	61	62	61	78	84
Dumptruck loads	0	929	1,000	929	1,000	0	697
Area fenced (hectare)	0	0	0	0	0	2.23	1.12
Area capped (hectare)	0	0.13	0	0.13	0	1.51	0
Transportation injuries to worker	0	0.0018	0.0018	0.0018	0.0018	0.0010	0.0013
Transportation fatalities to worker	0	0.0009	0.0010	0.0009	0.0010	0.0005	0.0007
Transportation injuries to the community	0	0.050	0.052	0.050	0.052	0.028	0.036
Transportation fatalities to the community	0	0.0033	0.0034	0.0033	0.0034	0.0018	0.0024
Construction injuries to worker	0	5.27	5.15	3.85	4.10	3.12	3.12
Construction fatalities to the worker	0	0.039	0.038	0.029	0.031	0.023	0.023
Total injuries	0	5.32	5.20	3.90	4.16	3.15	3.15
Total fatalities	0	0.044	0.043	0.033	0.035	0.026	0.026

Alt. 1: No Action
Alt. 2: Containment and Institutional Actions for Commercial/DOE and Other Remedial Unit Soils; Excavation and Disposal of Residential Remedial Unit Soils
Alt. 3: Excavation and Disposal of Commercial/DOE, Other, and Residential Remedial Units Soils
Alt. 4: Containment and Institutional Actions for Commercial/DOE and Other Remedial Units Soils; Excavation, Treatment, and Beneficial Reuse of Residential Remedial Unit Soils
Alt. 5: Excavation, Treatment, and Beneficial Reuse of Commercial/DOE, Other, and Residential Remedial Units Soils
Alt. 6: Containment and Institutional Actions for Commercial/DOE, Other, and DOE-Acquired (Previously Residential) Remedial Units Soils
Alt. 7: Institutional Actions for Commercial/DOE and Other Remedial Units Soils; Excavation and Disposal of Residential Remedial Unit Soils

EFPC = East Fork Poplar Creek
m = meter
$ = dollar

prevent exposure to the contaminants. No time would be required to implement the no action alternative. Monitoring would be undertaken for 30 years because risk would not be reduced to acceptable levels.

ALTERNATIVE 2: CONTAINMENT AND INSTITUTIONAL ACTIONS FOR COMMERCIAL/DOE AND OTHER REMEDIAL UNIT SOILS; EXCAVATION AND DISPOSAL OF RESIDENTIAL REMEDIAL UNIT SOILS

Under this alternative, all soil with mercury concentrations greater than the remediation goal in the Commercial/DOE and Other Remedial Units would be contained by a 45-cm (18-in.) soil cover with a subsoil animal intrusion barrier (netting). First, vegetation would be removed, and the stream bank stabilized. Netting would be installed, the soil placed over the contaminated area, and grass planted. Long-term maintenance and periodic environmental monitoring, including a CERCLA-required 5-year recurring review, would be performed. Institutional actions for the Commercial/DOE and Other Remedial Units would include future land-use limitations, construction permit restrictions, public education, and signs.

Soils with mercury concentrations greater than the remediation goal in the Residential Remedial Unit would be excavated and disposed of in a permitted landfill at the Y-12 Plant. A small area of one of the wetland areas would be remediated and restored. Clean borrow soil would be used to fill the excavation. Implementation of this alternative may involve building additional roads, removing vegetation and soils, grading excavated areas, and controlling surface runoff.

ALTERNATIVE 3: EXCAVATION AND DISPOSAL OF COMMERCIAL/DOE, OTHER, AND RESIDENTIAL REMEDIAL UNITS SOILS

Floodplain soils with mercury concentrations greater than the remediation goal would be excavated and disposed of in a permitted landfill at the Y-12 Plant. A small area of wetland would be remediated and restored. Clean borrow soil would be needed to fill the excavation. Implementation of this alternative may involve building additional roads, removing vegetation and soils, grading excavated areas, and controlling surface runoff.

ALTERNATIVE 4: CONTAINMENT AND INSTITUTIONAL ACTIONS FOR COMMERCIAL/DOE AND OTHER REMEDIAL UNITS SOILS; EXCAVATION, TREATMENT, AND BENEFICIAL REUSE OF RESIDENTIAL REMEDIAL UNIT SOILS

This alternative would cover Commercial/DOE and Other Remedial Units with mercury concentrations greater than the remediation goal with 45 cm (18 in.) of uncontaminated soil and

netting. Also, institutional actions as described for Alternative 2 would be implemented. All vegetation would be removed, and the stream bank stabilized.

Residential Remedial Unit soils with mercury concentrations greater than the remediation goal would be excavated and treated on site in a low-temperature thermal desorption unit. Treated soils would be enhanced with organic matter, nutrients, and water and used as fill in the excavated areas within the Lower EFPC floodplain. A small wetlands area would be remediated and restored.

Implementation of this alternative would involve treatment, which, through the process of waste concentration, may produce a Resource Conservation and Recovery Act-characteristic waste, a low-level radioactive waste, and/or air emissions. Also, as with Alternative 2, additional roads may be constructed, vegetation and soils removed, excavated areas graded, and surface runoff controls installed. The treatment process residuals, or secondary waste streams, would be packaged for shipment to an approved or licensed off-site disposal facility as necessary. Air emissions would be analyzed for hazardous pollutants. Consultation with TDEC and EPA would be required to comply substantively with the requirements of any permitting processes.

ALTERNATIVE 5: EXCAVATION, TREATMENT, AND BENEFICIAL REUSE OF COMMERCIAL/DOE, OTHER, AND RESIDENTIAL REMEDIAL UNITS SOILS

For this alternative, floodplain soils with mercury concentrations greater than the remediation goal would be excavated and treated on site in a low-temperature thermal desorption unit. Treated soil would be enhanced and returned to the excavation, and a small wetlands area would be remediated and restored. This alternative would also involve treatment, which, through the process of waste concentration, may produce Resource Conservation and Recovery Act-characteristic waste, low-level radioactive waste, and/or air emissions.

ALTERNATIVE 6: CONTAINMENT AND INSTITUTIONAL ACTIONS FOR COMMERCIAL/DOE, OTHER, AND DOE-ACQUIRED (PREVIOUSLY RESIDENTIAL) REMEDIAL UNITS SOILS

For Alternative 6, DOE would acquire the real estate right to fence and contain the NOAA site. One area would be contained by a 45-cm (18-in.) soil cover and netting as described in Alternative 2. DOE would also acquire, fence, and contain the remaining property in the Residential Remedial Unit containing soils with mercury concentrations above the remediation goal. The remaining floodplain soils with mercury concentrations above the remediation goal would be contained by a 45-cm (18-in.) soil cover and netting but not fenced. The DOE real estate acquisition could include easement, right-of-way, and property procurement. Long-term

maintenance and periodic environmental monitoring, including a 5-year recurring review, would ensure that levels of risk remain acceptable. Institutional actions would include future land-use limitations, construction permit restrictions, public education, and signs.

ALTERNATIVE 7: INSTITUTIONAL ACTIONS FOR COMMERCIAL/DOE AND OTHER REMEDIAL UNITS SOILS; EXCAVATION AND DISPOSAL OF RESIDENTIAL REMEDIAL UNIT SOILS

Alternative 7 addresses remedial actions on an area-specific basis. For this alternative, DOE would acquire the real estate rights to and fence the NOAA site. Soil containing mercury above the remediation goal would remain uncovered inside the fenced area. Institutional actions, including land-use restrictions, would be implemented.

In the Residential Remedial Unit, all remaining soil with mercury concentrations greater than the remediation goal would be excavated and disposed of in a permitted landfill at the Y-12 Plant. Clean borrow soil would be used to fill the excavation.

In the remaining areas of the Commercial/DOE and Other Remedial Units, institutional actions would be implemented to maintain nonagricultural and nonresidential land use. Institutional action in these areas and in the fenced areas would include future land-use limitations, construction permit restrictions, public education, signs, environmental monitoring, and a 5-year recurring review. Implementation of this alternative would involve activities very similar to those described for Alternatives 3 and 6.

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

DOE, TDEC, and EPA evaluated all alternatives against the nine criteria provided by CERCLA for final remedial actions. This comparative analysis is provided here.

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Overall protection of human health and the environment addresses whether an alternative provides adequate long- and short-term protection of human health and the environment from unacceptable risks from hazardous substances by reducing, eliminating, or controlling exposure and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls. All of the alternatives, with

the exception of the no action alternative, adequately protect human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, or institutional actions.

The greatest risk associated with Alternatives 2 through 7 would be to ecological receptors. Alternatives 3 and 5 would eliminate unacceptable residual risk in the floodplain and would not permanently alter floodplain habitat. These alternatives would impact ecological receptors in small areas and recovery might be slow. Alternative 7 would provide a high degree of overall protection to human health but would leave residual risk for ecological receptors. Alternatives 2 and 4 would permanently alter habitat and land use, and residual contaminants would remain. Alternative 6 provides the least overall protection of the action alternatives because containment and extensive fencing throughout the floodplain would permanently alter habitat, and long-term maintenance of fencing and access controls is considered difficult.

The no action alternative is not considered further in this analysis because it does not protect human health and the environment.

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Compliance with applicable or relevant and appropriate requirements (ARARs) addresses whether a remedy will meet all ARARs of all federal and state environmental statutes and/or provide grounds for invoking a waiver. Alternatives 2 through 7 would comply with identified federal and state ARARs. No waivers would be necessary to implement any of the remedial alternatives. The "Statutory Determinations" section summarizes the ARARs for the selected remedy.

LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness and permanence refers to the magnitude of expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environmental over time, once cleanup goals have been met. Alternatives 3 and 5 provide the greatest degree of long-term effectiveness and permanence because they would remove all contaminated material above levels of concern from the OU. Alternatives 2 and 4 provide slightly less long-term effectiveness and permanence because some of the contaminated material would remain in the floodplain and be covered by 45 cm (18 in.) of soil. Alternative 7 provides less long-term effectiveness and permanence than Alternatives 2 and 4 because only institutional actions limit contact with the contaminated material in the floodplain. Maintenance of fencing and land-use

restrictions would be required for long-term effectiveness in some areas. Alternative 6 provides the least amount of long-term effectiveness and permanence because all contaminated material would remain in place, and access would be restricted by fencing.

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Reduction of toxicity, mobility, or volume through treatment addresses the anticipated performance of treatment that permanently and significantly reduces toxicity, mobility, or volume of waste. Alternatives 4 and 5 would reduce the toxicity of mercury-contaminated soil through low-temperature thermal desorption. None of the other alternatives include treatment processes.

SHORT-TERM EFFECTIVENESS AND ENVIRONMENTAL IMPACTS

Short-term effectiveness considers impact to community, site workers, and the environment during construction and implementation and includes the time until protection is achieved. All of the alternatives involve minimal transportation and construction accident risks. Risk to the community and to workers from exposure to contaminants would be within acceptable limits because engineering controls and a project-specific health and safety plan, including personal protective equipment, would be used. A floodplain statement of findings, provided as an appendix to the feasibility study (DOE 1994b), is the resultant document from the floodplain assessment of Lower EFPC. The statement of findings concludes that there is no practicable alternative to remediating the Lower EFPC floodplain soil that would not destroy any wetland areas.

Alternative 7 would have the least impact on the environment because only a small area of floodplain habitat would be destroyed. Alternatives 2, 3, and 6 would have a greater adverse effect on the environment than Alternative 7 because they involve excavation of a larger area of contaminated floodplain soil. Alternatives 4 and 5 would have the largest impact on the environment because implementation would destroy the largest area of habitat of the alternatives, and treatment would involve additional handling of the soil.

IMPLEMENTABILITY

Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution. Alternatives 2 and 3 are most readily implementable because they involve only excavation, disposal, containment, and institutional actions that are commonly used and readily implementable. Alternative 7 would be slightly more difficult to implement because of the additional separate actions required to

acquire a portion of land and restrict access by fencing. Alternative 6 would be less implementable if landowners were reluctant to negotiate agreements with DOE for contaminated portions of their property. Long-term maintenance of the soil cover and fencing may also be difficult. Alternatives 4 and 5 may be the hardest to implement because they include a treatment process, low-temperature thermal desorption, for which full-scale effectiveness and implementability have not been proven. Low-temperature thermal desorption is an EPA-accepted, best demonstrated available technology, effective in removing mercury from Lower EFPC soils in bench-scale and pilot-scale tests.

COST

Cost compares the differences in cost, including capital and operation and maintenance costs, expressed as estimated total present-worth cost. Alternative 7 is the least expensive action alternative. The next lowest-cost alternatives are Alternatives 6, 2, and 3. Alternatives 4 and 5 are the most expensive.

STATE ACCEPTANCE

State acceptance evaluates whether the state agrees with, opposes, or has no comment on the preferred alternative. The state of Tennessee concurs with the selected remedy.

COMMUNITY ACCEPTANCE

Community acceptance addresses the issues and concerns the public may have regarding each of the alternatives. The proposed plan (DOE 1995b) presented Alternative 3, as previously described, as DOE, EPA, and TDEC's preferred alternative. The "Selected Remedy" section reflects a compromise of the many public comments on the proposed plan. The "Highlights of Community Participation" section summarizes community participation. Part 3, the "Responsiveness Summary," summarizes and responds to comments submitted during the public comment period.

SELECTED REMEDY

Based on a comparative analysis of the alternatives presented in the feasibility study (DOE 1994b), Alternative 3 is selected as the remedial action. This alternative reflects the best balance of the evaluation criteria. The remediation goal that is protective of human health and the environment is 400 ppm mercury.

The selected remedy addresses soil contaminated with mercury at concentrations greater than 400 ppm by excavating and disposing of the identified highly contaminated floodplain soils. The major components of the selected remedy include:

- The areas to be excavated include three areas at the NOAA site (Parcels #571 and #461) and one area at the Bruner's Center Site (Parcel #564). Figures 2.2, 2.3, and 2.4 delineate the areas. The mercury contamination above 400 ppm in the three areas at the NOAA site extend approximately 40 cm (16 in.) deep. Figure 2.2 shows the 400 ppm contours for the NOAA site. No jurisdictional wetlands at the NOAA site would be excavated. The mercury contamination above 400 ppm in the area to be excavated at the Bruner's Center site extends to 80 cm (32 in.) deep, as shown in Figures 2.3 and 2.4. Figure 2.3 shows the 400 ppm contour for the soil from the surface to 40 cm (16 in.) deep. Figure 2.4 the 400 ppm contour for the soil from 40 cm (16 in.) to 80 cm (32 in.) deep. Excavation will be conducted using standard construction machinery.

- For disposal, the excavated contaminated soil would be loaded into standard dump trucks and transported to the Y-12 Plant. The soil will then be deposited in a modification or expansion of an existing, state-approved, permitted, lined, Subtitle D landfill at the Y-12 Plant. The landfill will have leachate collection capabilities and, if necessary, any leachate collected will be pretreated before discharge.

- The only jurisdictional wetland area affected is a 0.24-ha (0.6-acre) portion of Wetland COE ID #8 at the Bruner's Center Site. The contaminated soil in the wetland is remediated through excavation and disposal. The wetland will then be restored in the same location. No delineated wetlands at the NOAA site will be affected by implementation of the selected remedy.

- Verification sampling will ensure that all soil with mercury concentrations above 400 ppm in each of the designated areas is excavated. Results of analyzed samples below 400 ppm will verify that excavation is complete.

- All areas excavated will be backfilled with clean soil. The clean soil will either be transported from another area such as the DOE ORR, or nearby soil in the same parcel will be recontoured, thereby providing fill material for the excavation. Similar vegetation to that removed during excavation will be replaced at all excavated areas.

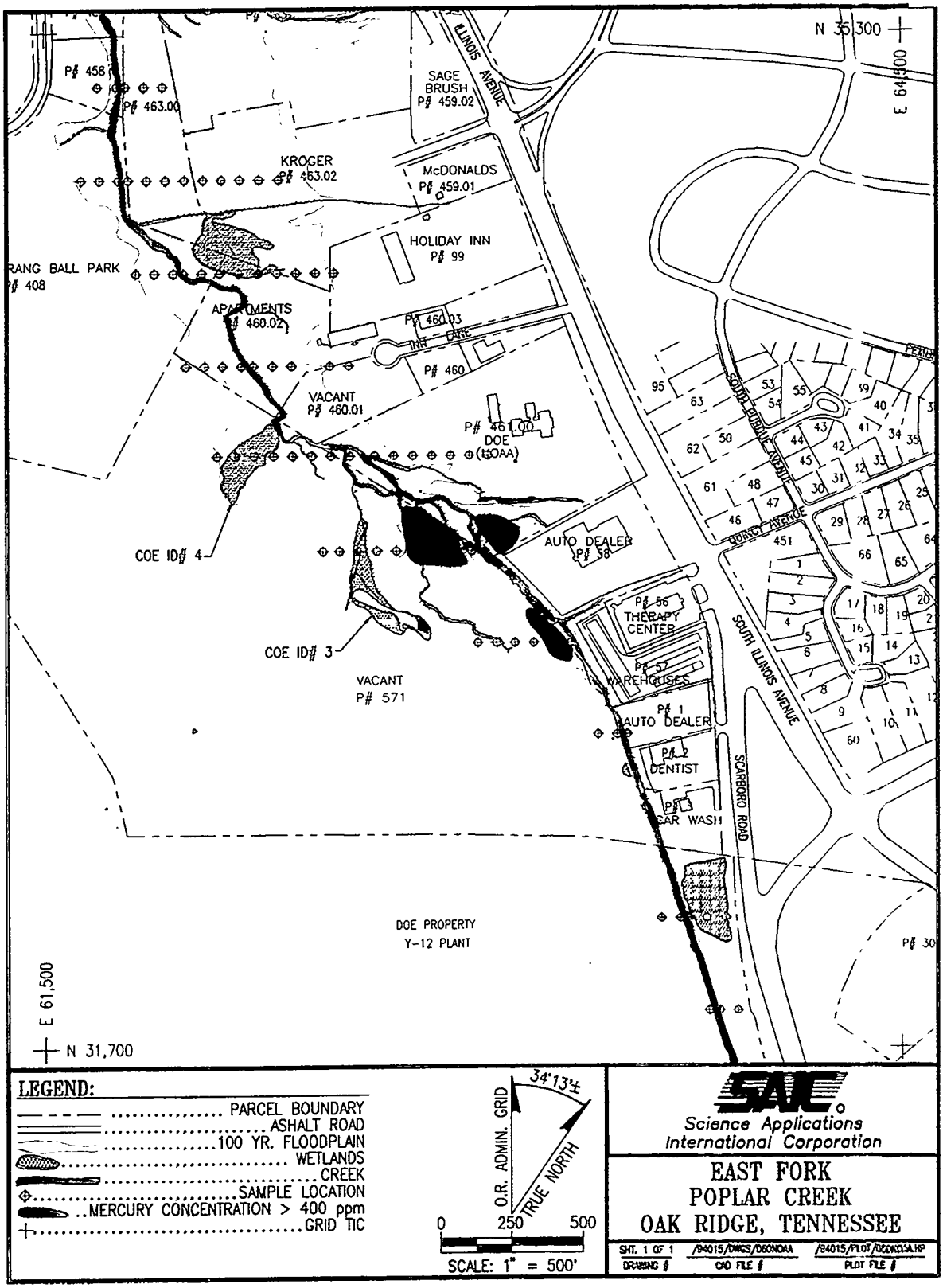


Fig. 2.2. Mercury concentrations 0–16 in. at NOAA site.

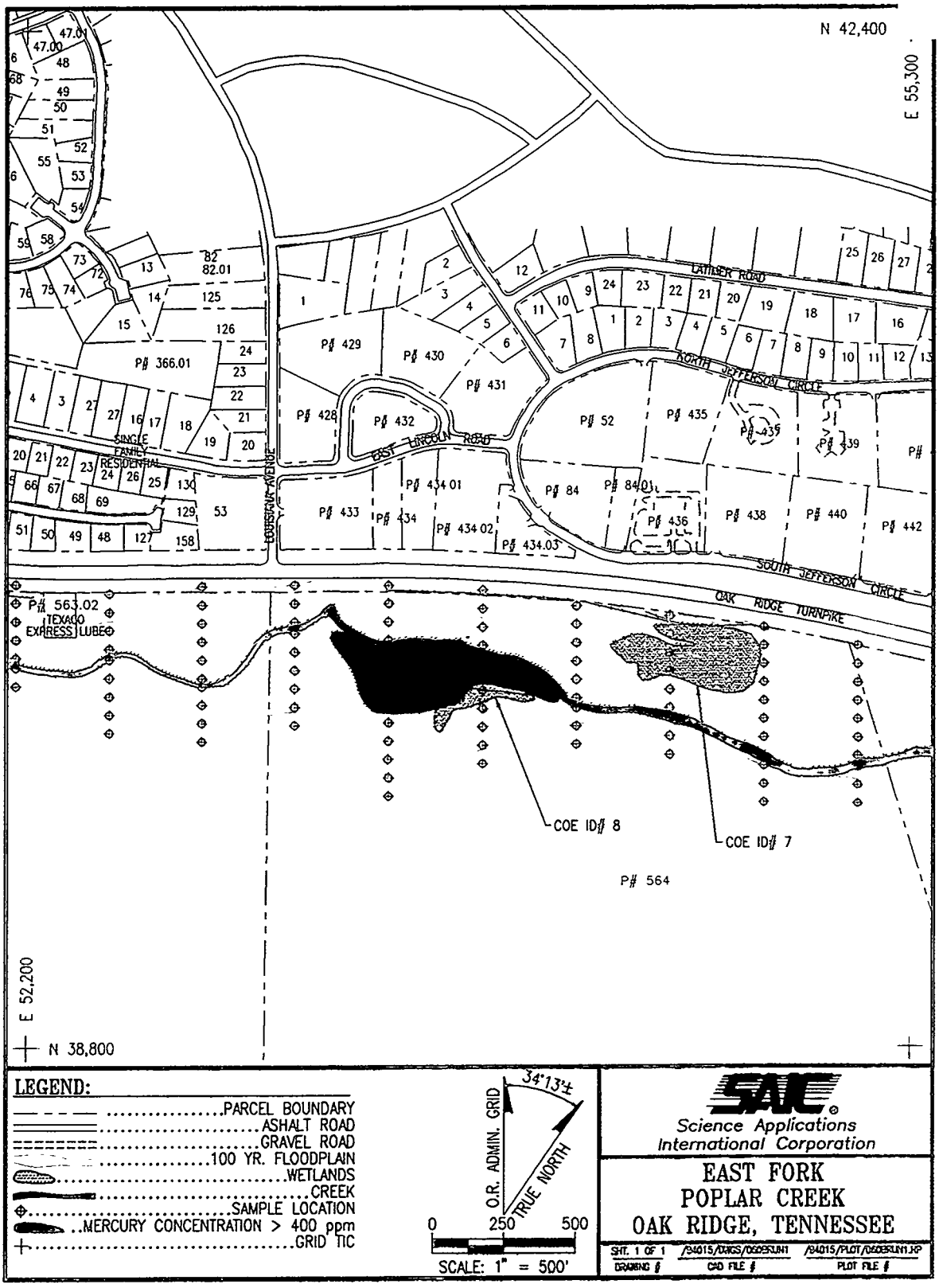


Fig. 2.3. Mercury concentrations 0–16 in. at Bruner's Center Site.

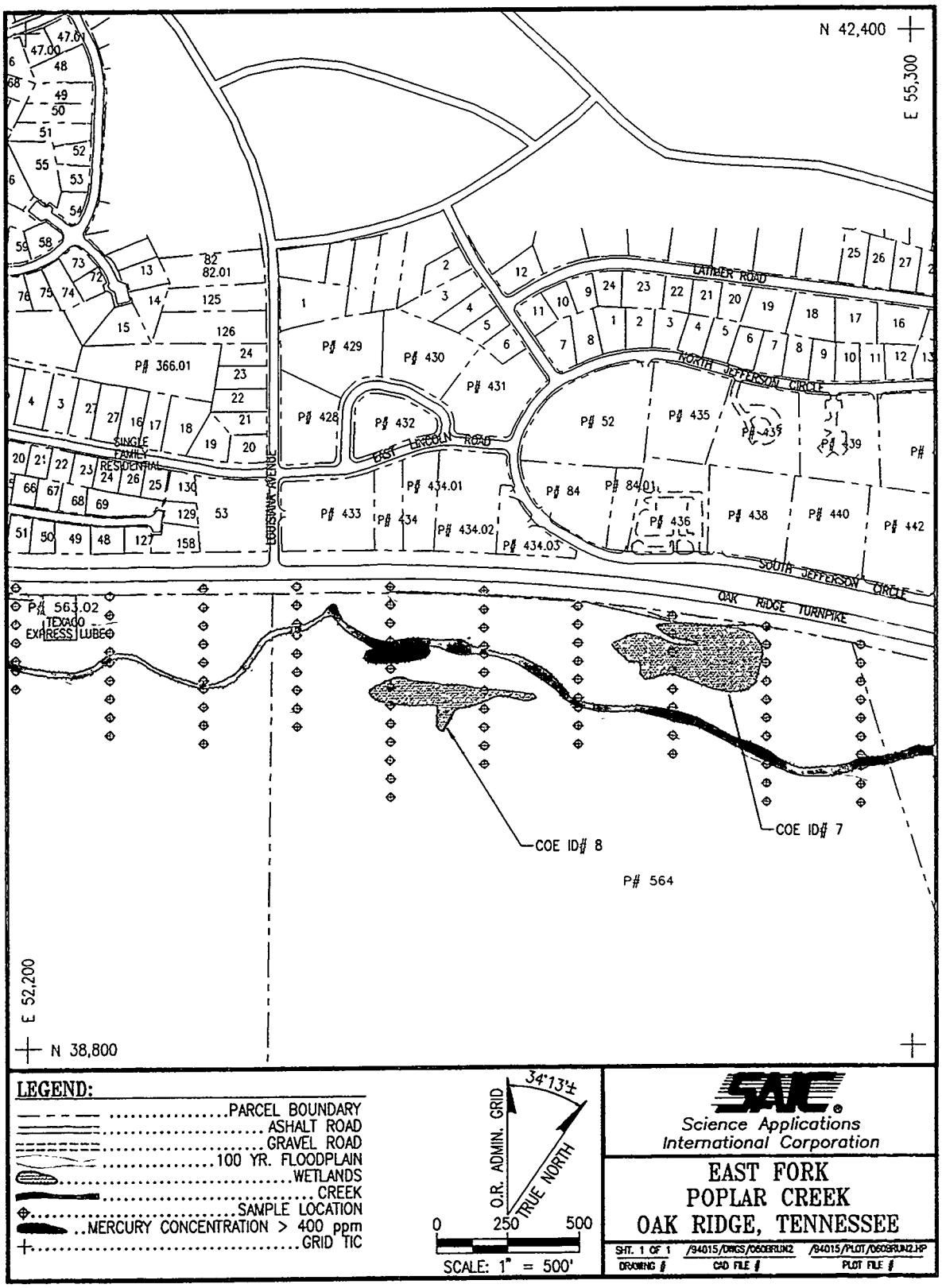


Fig. 2.4. Mercury concentrations 16–32 in. at Bruner's Center Site.

- Appropriate monitoring (sampling and analysis) of the identified areas in the Lower EFPC floodplain will be conducted to ensure effectiveness of the remediation.

DOE will monitor to detect any future residential use of the shallow soil horizon groundwater. In the unlikely event such use occurs, DOE will mitigate, as appropriate, any risk associated with such use.

Implementation of the selected remedy is estimated to cost $22.3–27.9 million. A breakdown of the cost components is provided in Table 2.2. The cost is in escalated dollars. Design includes the design, review, and permitting of the cleanup activities. Cleanup includes excavation and drying of the identified soil, transportation of the soil to the landfill, acceptance at the landfill, and upgrades to the landfill leachate storage system. The indirect and overhead value includes costs for project management, administrative support, and overhead. The O&M value consists of the cost of operating and maintaining the landfill leachate storage system and monitoring the floodplain for 5 years. The contingency value allows for unforeseen costs not included in the design, cleanup, indirect and overhead, and O&M costs.

STATUTORY DETERMINATIONS

Section 121 of CERCLA establishes several statutory requirements and preferences, including compliance with ARARs. Statutory requirements specify that, when complete, the selected remedy must be cost effective. It must use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the

Table 2.2. Costs components of the selected remedy

Component	Cost ($million)
Design	1.4
Cleanup	12.1
Indirect and overhead	5.0
O&M	3.8
Contingency	3.6
Total	22.3–27.9

O&M = operating and maintenance

statute includes a preference for remedies that employ treatment that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element.

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy is protective of human health and the environment through removal of the principal contaminated soils in the 100-year floodplain of Lower EFPC. In so doing, the risk is reduced for human ingestion of contaminants and for uptake of contaminants into biota.

COMPLIANCE WITH ARARS

All alternatives considered for Lower EFPC were in compliance with identified ARARs. The selected remedy meets all ARARs, which are listed in Table 2.3.

Chemical-specific ARARs for the site include maximum containment levels (MCLs) and secondary MCLs for drinking water promulgated and legally enforceable under Tennessee law. These are relevant and appropriate for groundwater below the shallow soil horizon. Manganese concentrations exceed secondary MCLs in the Oak Ridge area because background concentrations are high. Therefore, the secondary MCL for manganese is excepted from the relevant and appropriate requirements for groundwater.

Location-specific ARARs include requirements to avoid or minimize adverse impacts to wetlands. When such impacts cannot be avoided, mitigation and compensation are required. The selected alternative involves disturbance of approximately 0.24 ha (0.6 acre) of wetlands at the Bruner Center location. These wetlands primarily serve as wildlife habitat, but also have low floodflow attenuation and sediment retention functions. The disturbed area will be remediated and restored. A wetlands and floodplain assessment was performed, per 10 *Code of Federal Regulations* (CFR) 1022, as part of the remedial investigation, after the wetlands were delineated by the U.S. Corps of Engineers (DOE 1994a). A wetlands mitigation plan must be prepared and approved by DOE with the concurrence of EPA, the state of Tennessee, and the U.S. Corps of Engineers before initiation of activities in the wetlands.

Since the remedial action will occur in a floodplain, actions must minimize any unavoidable adverse impacts. A notice of floodplain and wetlands involvement was published for the actions in the Lower EFPC wetlands and floodplain on October 4, 1993 (58 *Federal Register* 51623-4). A floodplain assessment was performed (DOE 1994b) as mentioned above. A statement of findings was subsequently published in compliance with review requirements for

Table 2.3 Chemical-, location-, and action-specific ARARs and TBC guidance for site-wide Alternative 3 at EFPC – Sewer Line Beltway

Actions	Requirements	Citation
Chemical-specific		
Presence of contaminants in deep groundwater	Must comply w/ SDWA, MCLs, and SMCLs excluding the SMCL for manganese (which is naturally occurring) for groundwater below 20 ft from the soil surface - **relevant and appropriate**	40 CFR 140 *et seq.*; TDEC 1200-5-1 *et seq.*
Location-specific		
Presence of wetlands as defined in Executive Order 11990 §7(c)	Whenever possible, actions involving federal activities and programs affecting land use must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. New construction in wetlands areas should be particularly avoided unless there are no practicable alternatives. Wetlands protection considerations shall be incorporated into planning, regulating, and decision-making processes - **applicable**	Executive Order 11990; 10 CFR 1022
Presence of jurisdictional wetlands as defined in 40 CFR 230.3(t) and 33 CFR 328.3(b)	Action to avoid degradation or destruction of wetlands must be taken to the extent possible. Discharges for which there is a practicable alternative with less adverse impacts or those which would cause or contribute to significant degradation are prohibited - **applicable**	Clean Water Act §404 40 CFR 230 33 CFR 323
	Must comply with the general and specific terms and conditions of NWP 13 (*Bank Stabilization*), NWP 14 (*Road Crossings*), NWP 18 (*Minor Discharges*), NWP 38 (*Cleanup of Hazardous and Toxic Waste*), or others if authorized by COE for minor adverse environmental effects - **applicable**	33 CFR 330, Appendix A
	Must comply with the substantive requirements of the individual permitting process for alterations to "waters of the U.S." which cause more than minimal individual or cumulative adverse environmental effects - **applicable**	33 CFR 325.1
Within area encompassing or affecting waters of the state of Tennessee as defined in TCA 69-3-103(32)	Discharge of "substances" into the waters of the state which "will result or will likely result in harm, potential harm or detriment to the health of animals, birds, fish, or aquatic life" is prohibited - **applicable**	TCA 69-3-101 *et seq.*

Table 2.3. (continued)

Actions	Requirements	Citation
	Must comply with the substantive requirements of the aquatic resource alteration individual or general permits for activities such as noncommercial sand and gravel dredging, bank stabilization, minor road crossings, wetlands disturbance - **applicable**	TDEC 1200-4-7
Within "lowland and relatively flat areas adjoining inland and coastal waters and other floodprone areas...." [Executive Order 11988 §6(c)]	Action shall be taken to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of floodplains during federal activities involving acquisition, management, and disposition of lands and facilities or conducting any federal activities and programs affecting land use. The potential effects of actions in floodplains shall be evaluated and consideration of flood hazards and floodplain management ensured. If action is taken in floodplains, alternatives that avoid adverse effects and incompatible development and minimize potential harms shall be considered - **applicable**	Executive Order 11988 10 CFR 1022
Presence of federally owned, administered, or controlled prehistoric or historic resources *-or-* the likelihood of undiscovered resources	Cultural resources included in or eligible for inclusion in the National Register of Historic Places (36 CFR 60) or National Historic Landmark Program (36 CFR 65) must be identified - **applicable** Action(s) that will affect such resources must be identified and alternatives to the action(s) examined and considered - **applicable** When alteration or destruction of a resource is unavoidable, steps must be taken to minimize or mitigate the impacts - **applicable** When alteration or destruction of a resource is unavoidable, steps must be taken to preserve records and data of the resource - **TBC*** Consultation with SHPO should be conducted if cultural resources are inadvertently discovered during remediation activities - **TBC***	National Historic Preservation Act (16 USC 470a-w) Executive Order 11593 36 CFR 800
	Consultation should be initiated with the SHPO and Advisory Council on Historic Preservation before the initiation of any groundbreaking activities to determine the need for any additional archaeological or historic survey work and the need for an MOA regarding protection of archaeological resources - **TBC***	16 USC 470f 36 CFR 800

Table 2.3. (continued)

Actions	Requirements	Citation
Presence of archaeological resources on public land	Steps must be taken to protect archaeological resources and sites for any action involving alteration of terrain which might cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeologic data - **applicable**	Archaeological Resources Recovery Act of 1979 (16 USC 470aa-ll); 43 CFR 7
Presence of archaeologic or historic resources	A survey of affected areas for resources and data should be conducted and steps taken to recover, protect, and preserve data therefrom or request that DOI do so; the Secretary of Interior must be advised of the presence of the data - **TBC***	Archaeological and Historic Preservation Act (16 USC 469a-c)
Action-specific		
Construction/excavation/ transport of soils	Must take reasonable precautions to prevent particulate matter from becoming airborne during handling or transporting of any materials - **applicable**	TDEC 1200-3-8-.01
Surface water control	Comply with the substantive requirements of the stormwater permitting process for discharges associated with construction activity, including clearing, grading, and excavation that result in a disturbance of 5 acres or more total land and implement good site planning and BMPs to control stormwater - **applicable; relevant and appropriate** for less than 5 acres	TDEC 1200-4-10-.05
	Implement a BMP to address each component of a system capable of causing a release of significant amounts of hazardous or toxic pollutants to waters of the U.S. - **applicable**	40 CFR 125.104 TDEC 1200-4-3-.06
	All cost-effective and reasonable BMPs for nonpoint source control shall be implemented - **applicable**	TDEC 1200-4-3-.06
Waste pile	Pile used for the storage of particulate RCRA hazardous waste must be managed to control wind erosion and surface water runoff - **relevant and appropriate** to soil containing RCRA constituents	40 CFR 264.250(c); TDEC 1200-1-11-.06(-12)(b)
Treatment and disposal of decontamination/dewater-ing fluids	A person who generates solid waste must determine whether that waste is hazardous using various methods, including TCLP or application of knowledge of the hazardous characteristics of the waste based on information regarding the materials or processes used - **applicable** to the mercury-contaminated solid waste contained in the soil.	40 CFR 262.11 TDEC 1200-1-11-.03(1)(b)

Table 2.3. (continued)

Actions	Requirements	Citation
Direct discharge to surface water body	Must meet water quality criteria for the designated use - **relevant and appropriate**	TDEC 1200-4-3; TDEC 1200-4-4
	Must meet NPDES permit limitations for any discharge via permitted outfalls - **applicable**	TDEC 1200-4-5
Discharge to publicly owned treatment works (POTW)	Pollutants that pass through the POTW without treatment, interfere with POTW operation, or contaminate POTW sludge are prohibited - **applicable**	40 CFR 403.5
	Discharge must comply with local POTW pretreatment standards - **applicable**	40 CFR 403.5(d)
Disposal of carbon adsorption filters	A person who generates solid waste must determine whether that waste is hazardous using various methods, including TCLP or application of knowledge of the hazardous characteristics of the waste based on information regarding the materials or processes used - **applicable**	40 CFR 262.11 TDEC 1200-1-11-.03(1)(b)

*Although administrative and procedural requirements are not ARARs for on-site CERCLA activities, adherence to these steps is strongly recommended by EPA because of the effectiveness of these procedures in identifying and protecting sensitive resources.

ARAR = applicable or relevant and appropriate requirement
BMP = best management practices
CFR = *Code of Federal Regulations*
COE = U.S. Corps of Engineers
DOI = U.S. Department of the Interior
EPA = U.S. Environmental Protection Agency
ft = foot
MCL = maximum contaminant level
MOA = memorandum of agreement
NPDES = National Pollutant Discharge Elimination System
NWP = nationwide permit
POTW = publicly owned treatment works
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
SHPO = State Historic Preservation Officer
SMCL = secondary maximum containment level
TBC = to be considered
TCA = *Tennessee Code Annotated*
TCLP = Toxicity Characteristic Leaching Procedure
TDEC = Tennessee Department of Environment and Conservation
USC = United States Code

floodplains (10 CFR 1022). The finding showed there is no practicable alternative to the proposed action. The Statement of Findings is provided in the feasibility study (DOE 1994b) and will be published in the *Federal Register* before the action is initiated. It specifies several measures that DOE will take to minimize potential harm within the affected floodplain. These include, but are not limited to implementation of soil erosion and sediment control measures; avoidance of stream obstruction; restoration of original contours; haul roads not to follow the shoreline; minimization of disturbance; and use of mats, low-pressure ground machines, or extended-reach excavating equipment.

Other location-specific ARARs are related to cultural resources and would be invoked only if discoveries of cultural resources should be made during remedial activities.

Action-specific ARARs for remedial action at Lower EFPC include requirements for surface water controls using site planning and best management practices to minimize adverse effects from erosion and stormwater discharges into the creek, which could result from activities such as clearing, grading, and excavation. Precautions must be taken to prevent fugitive dust that may result from handling and transport of soils from becoming airborne.

A best management practices plan must be prepared and followed to address minimizing the potential to release hazardous substances into surface waters (40 CFR 125.104, TDEC 1200-4-3-.06), to control stormwater discharges (40 CFR 122, *Tennessee Code Annotated* 69-3-108 et seq), and for nonpoint source controls. These practices will be identified by complying with the substantive requirements of the stormwater permitting process (40 CFR 122, TDEC 1200-4-10-.05).

Waste generators are required to determine whether the waste is hazardous (40 CFR 262.11, TDEC 1200-1-11-.06). Previous sampling has indicated that the soils at Lower EFPC are not hazardous as defined by Resource Conservation and Recovery Act. Excavated soils will be disposed of in a solid waste landfill at the Y-12 Plant on ORR as a special waste (TDEC 1200-1-7-.01 et seq.).

COST EFFECTIVENESS

Actions under CERCLA must consider the estimated total present-worth costs of the alternatives. Alternative 3 is cost effective for the protection of human health and the environment.

UTILIZATION OF PERMANENT SOLUTIONS TO THE MAXIMUM EXTENT PRACTICABLE

DOE believes the selected remedy represents the maximum extent to which permanent solutions can be used in a cost-effective manner for Lower EFPC. Of the remediation alternatives that protect human health and the environment and comply with ARARs, DOE believes that the selected remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost.

The selected remedy permanently eliminates the principal threats posed by the soil by removing it from the floodplain. This remedy provides a high degree of protectiveness and costs less than treatment.

PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

Treatment of the principal threat from the soils was not found to be practicable based on the large volume of low concentrations of material. Therefore, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. However, this remedy will result in remediation of hazardous substances and allow unlimited use of and restricted exposure to the Lower EFPC OU.

DOCUMENTATION OF SIGNIFICANT CHANGES

The preferred alternative presented in the proposed plan (DOE 1995b) was Alternative 3. Extensive public comment on the proposed plan indicated a need to reassess the remediation goal for mercury. Many commentors argued to increase the cleanup level, and some commentors argued to lower it. Several technical arguments were advanced, which challenged the conservative nature of the risk assessment. In response to the public comments, including those requesting a more conservative cleanup level, DOE revisited the assumptions used in the derivation of the remediation goal for protection of human health and the environment. This reassessment is part of the risk management process for EFPC.

REASSESSMENT OF THE HUMAN HEALTH REMEDIATION GOAL FOR LOWER EFPC SOILS

DOE, in developing the remediation goal for mercury in soil, attempted to derive the most appropriate, scientifically valid, and protective target concentration possible. A value of 180 ppm

was developed to protect children (the most sensitive receptor group) from direct exposure to mercury through inadvertent soil ingestion and dermal contact (DOE 1994c). Several public comments indicate a preference for a less conservative remediation goal for mercury in soils. Residents urged DOE and EPA to derive a remediation goal based more on measures of central tendency (i.e., closer to average values) rather than high end (i.e., upper bound) exposure estimates and toxicity.

The bioavailability of mercury in EFPC soils, and the EPA oral reference dose (toxicity measure) for mercury species significantly influence the development of the remediation goal for mercury. The magnitude of the remediation goal estimate is inversely proportional to the bioavailability factor and directly proportional to the reference dose. That is, the greater the availability of mercury in soil, the greater the uptake and dose, and the lower the target cleanup level needs to be (i.e., greater exposure means greater need for protection). Conversely, the higher the value of the oral reference dose for mercury species under evaluation, the less toxic the form of mercury and the higher the target cleanup level may be.

During the remedial investigation, DOE had conducted a reevaluation of the available toxicity data of mercury as part of the baseline risk assessment (DOE 1994a). The EPA oral reference dose for mercury was based on exposure of laboratory animals to mercuric chloride, a highly mobile (available) form of mercury not found in EFPC. An alternate reference dose was derived for mercuric sulfide and submitted to the EPA Environmental Criteria Assessment Office (Cincinnati, Ohio). EPA Environmental Criteria Assessment Office reviewed the analysis submitted and decided that data were insufficient to support the acceptance of an alternate reference dose for mercury sulfide. The remediation goal was, therefore, derived using a conservative oral reference dose value of 0.0003 mg/kg-day published in the EPA Health Effects Assessment Summary Tables [HEAST Fiscal Year 1993-94 (EPA 1992a)]. Note that the oral reference dose for mercury had been withdrawn from the EPA Integrated Risk Information System [(EPA 1993), the primary source of EPA toxicity data] pending further review.

As noted previously, DOE derived the remediation goal of 180 ppm taking into consideration bioavailability of mercury species in EFPC floodplain soil. Data on the bioavailability of mercury (i.e., mercuric sulfide and elemental mercury) in EFPC were empirically derived from leaching/availability studies conducted by Oak Ridge National Laboratories on contaminated samples of EFPC soil. Data from these studies were aggregated and statistically evaluated. The simulation was also used to examine the uncertainty surrounding the estimate of bioavailability of mercury species (DOE 1994c). The analysis generated a probability distribution that graphically depicts the range of possible values for mercury

bioavailability in EFPC soils. The bioavailability factor selected in deriving the RGO of 180 ppm for mercury (see equation 1 DOE 1994c) was 30 percent and corresponds approximately to the 94th percentile of the probability distribution.

At this point in the planning process, DOE and EPA have made a risk management decision to use a bioavailability factor for mercury corresponding to the 85th percentile of the probability distribution. The 85th percentile of the distribution corresponds to a bioavailability factor of 10 percent and results in a calculated remediation level of approximately 400 ppm of soil. Given that insoluble/unavailable forms of mercury predominate in EFPC, the 85th percentile of the probability distribution (i.e., 10 percent bioavailability) still affords considerable protection to human health. It is still a more conservative value than some commentors felt was justified, but not as conservative a value as requested by others. It is, however, scientifically defensible and sufficiently protective of the most sensitive receptor group (i.e., children) for direct contact with soils.

REASSESSMENT OF THE ECOLOGICAL REMEDIATION GOAL FOR LOWER EFPC SOILS

The preferred remedial alternative identified in the proposed plan included an ecological remediation goal for mercury in soil of 200 ppm. The remedy selected in the ROD contains an ecological remediation goal for mercury in soil of 400 ppm. The increase in the remediation goal is based on the determination that the harm that would be caused to ecological receptors in the short-term from removal of soil contamination in the 200–400 ppm range outweighs the short- and long-term benefits of removing this soil because it would destroy valuable parts of the ecosystem, including wetlands, hardwood forests, and associated organisms.

DOE believes that further justification for the increase in the remediation goal is the conservative nature of the ecological risk assessment, which DOE believes tended to overstate the risk posed by contaminants.

SUMMARY OF CHANGES

Given the extensive knowledge of the EFPC soils, a change in the overall remediation (cleanup) goal from 180 to 400 ppm protects human health and the environment. The effect this

increased remediation goal has on the proposed plan's preferred alternative is shown in Table 2.4 and described here:

- With a remediation goal of 400 ppm, the total identified in situ volume of floodplain soils to be excavated is 7,650 m^3 (10,000 yd^3), comprised of four areas (three areas at the NOAA site and one area at the Bruner's Center site). In comparison, a remediation goal of 180 ppm corresponded to a soil volume of 41,300 m^3 (54,000 yd^3) in six different areas.

Table 2.4. Comparison of impacts of remediation goals of 180 ppm vs 400 ppm, EFPC for Selected remedy

Impact	Remediation Goal (ppm)	
	180	400
Cost ($ million)	36–78	22-48
Volume extracted (m^3)	41,300	7,646
Area impacted (hectares)	7.3	2.47
Wetlands area impacted (hectares)	0.6	0.25
Time to complete (weeks)	82	61
Dumptruck loads	6,750	1,000
Area fenced (hectares)	0	0
Area capped (hectares)	0	0
Transportation injuries to worker	0.01	0.0018
Transportation fatalities to worker	0.005	0.0010
Transportation injuries to the community	0.3	0.052
Transportation fatalities to the community	0.02	0.0034
Construction injuries to worker	10.3	5.15
Construction fatalities to the worker	0.008	0.038
Total injuries	~11	5.20
Total fatalities	0.1	0.043

$ = dollar
EFPC = East Fork Poplar Creek
m = meter
ppm = parts per million

- Contaminated soil would be disposed of in a state-approved landfill at the Y-12 Plant whether the remediation goal were 400 or 180 ppm. The volume requiring transportation and landfill space are much lower if the remediation goal is 400 ppm than if the remediation goal is 180 ppm (see volumes in previous bullet).

- A remediation goal of 400 ppm means that only 0.24 ha (0.6 acres) of low-quality wetlands would be excavated and would require mitigation. In comparison, a remediation goal of 180 ppm corresponded to excavation of 0.6 ha (1.5 acres) of low- and high-quality wetlands.

- The verification sampling method used does not depend on the remediation goal. However, since a smaller area would be excavated with a remediation goal of 400 ppm than with a remediation goal of 180 ppm, fewer samples overall would be required.

- Backfilling excavations would occur independently of the remediation goal. Again, however, a smaller volume of backfill would be required for the 400 ppm remediation goal than for the 180 ppm remediation goal.

- The revised Alternative 3 now includes appropriate monitoring (sampling and analysis) of Lower EFPC media to ensure effectiveness of the remedial action.

This significant change is a logical outgrowth of responding to public comments. An additional formal public comment period is not required for these changes in the selected remedy.

REFERENCES

DOE (U.S. Department of Energy). 1992. *Federal Facility Agreement for the Oak Ridge Reservation*. DOE/OR-1014, U.S. Environmental Protection Agency Region IV, Atlanta, GA, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, TN, and Tennessee Department of Environment and Conservation, Nashville, TN. January 1.

DOE. 1994a. *East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report*. DOE/OR/02-1119&D2. Prepared by Science Applications International Corporation, Oak Ridge, Tennessee; Submitted to U.S. Department of Energy under Contract No. DE-AC05-91OR21950.

DOE. 1994b. *Feasibility Study for the Lower East Fork Poplar Creek—Sewer Line Beltway.* DOE/OR/02-1185&D2, Volumes 1 and 2. Prepared by Science Applications International Corporation, Oak Ridge, Tennessee; Submitted to U.S. Department of Energy under Contract No. DE-AC05-91OR21950.

DOE. 1994c. *Addendum to the East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report.* DOE/OR/02-1119&D2/A1/R1. Prepared for U.S. DOE by Science Applications International Corporation (SAIC), Oak Ridge, TN.

DOE. 1995a. *Remedial Goal Options for Mercury in Sediment of East Fork Poplar Creek, Oak Ridge, Tennessee.* DOE/OR/01-1342&D2. Prepared for U.S. DOE by Science Applications International Corporation (SAIC), Oak Ridge, TN.

DOE. 1995b. *Proposed Plan, East Fork Poplar Creek—Sewer Line Beltway, Oak Ridge, Tennessee.* DOE/OR/02-1209&D3.

Eisler, R. 1987. *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* Biological Report **85**(1.10), Fish and Wildlife Service, U.S. Department of the Interior, Patuxent, MD.

EPA (U.S. Environmental Protection Agency). 1992a. *Health Effects Assessment Summary Tables (HEAST). Annual Update and Supplement Nos. 1 and 2.* OHEA ECAO-821. Office of Health and Environmental Assessment, Office of Research and Development, Washington, D.C., March.

EPA. 1992b. *Framework for Ecological Risk Assessment.* EPA 630/R-92/001. Risk Assessment Forum, Washington, D.C.

EPA. 1993. *Integrated Risk Information System (IRIS). U.S. Environmental Protection Agency On-line Database of Toxicity Measures.* Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, Ohio. Electronic Mail Account Information via TOXNET, National Library of Medicine, Bethesda, MD.

Hildebrand, S., J. Huckabee, F. Diaz, S. Janzen, J. Solomon, and K. Kumar. 1980. *Distribution of Mercury in the Environment at Almaden, Spain.* ORNL/TM-7446, Oak Ridge, TN.

Hinzman, R. L. (Ed.). 1993. *Second Report on the Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek.* Y/TS-888. Oak Ridge National Laboratory, Oak Ridge, TN.

Loar, J. M. (Ed.). 1992. *First Report on the Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek.* Y/TS-886. Oak Ridge National Laboratory, Oak Ridge, TN.

Scheuhammer, A. M. 1988. *Chronic Dietary Toxicity of Methyl/mercury in the Zebra Finch, Poephila guttata.* Bull. Environ. Contam. Toxicol. 40: 123-130.

Suter, G. W. II, B. E. Sample, D. S. Jones, and T. L. Ashwood. 1994. *Approach and Strategy for Performing Ecological Risk Assessments for the U.S. Department of Energy's Oak Ridge Reservation: 1994 Revision.* ORNL ES/ER/TM-33/RI.

PART 3. RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY

This responsiveness summary documents formal public comments on the *Lower East Fork Poplar Creek Proposed Plan* made during the Lower EFPC Public Meeting and those submitted in writing during the public comment period. The public meeting was held January 26, 1995, at Pollard Auditorium in Oak Ridge, Tennessee. The public comment period started January 9, 1995, and ended February 22, 1995. This responsiveness summary also presents DOE's response to all comments received.

Based on the evaluation of the remedial action alternatives for Lower EFPC, Alternative 3 is the selected remedy. This selected remedy is referred to in the feasibility study and is the preferred alternative in the proposed plan. The remedial alternative, as described in the feasibility study and proposed plan, involved excavating all soil in the floodplain that contains more than 180 ppm mercury and disposing of the soil in a Y-12 permitted landfill. The selected remedy has since been changed. The decision summary of this ROD presents the same remedial alternative but with a remediation goal of 400 ppm mercury instead of 180 ppm.

This responsiveness summary serves three purposes. First, it informs DOE, EPA, and TDEC about community concerns about the site and the community's preferences regarding the proposed remedial alternative. Second, it demonstrates how public comments were integrated into the decision-making process. Finally, it allows DOE to formally respond to public comments.

This report is prepared pursuant to the terms of the 1992 Federal Facility Agreement among DOE, EPA, and TDEC, as well as other requirements, including:

- CERCLA as amended by SARA, 42 United States Code, Section 9601, et seq.;
- NCP, 40 Code of Federal Regulations, Part 300; and
- *Community Relations in Superfund, A Handbook*, January 1992, EPA/540/R-92/009.

After reviewing the written comments and the transcript of verbal comments, DOE grouped comments according to common issues. DOE summarized each comment and prepared a response to each issue.

A corresponding comment code is provided at the end of each comment. Numbers that start with "028" correspond to written comments submitted to DOE during the public comment period. The number is the log number used by the Information Resource Center, the repository

that maintains the Administrative Record and has copies of all comments received. Codes in the form of PMxx (where xx denotes a two-digit number) correspond to verbal comments from the public meeting transcript. A list of commentors and the corresponding comment codes are provided in Appendix A.

ISSUE 1: THE REMEDIATION GOAL IS TOO LOW

Several commentors say that EPA's risk assessment methodology is too conservative and that this results in an overly conservative remediation goal, an overly conservative approach to the protection of human health and the environment, and that implementing cleanup based on a remediation goal of 180 ppm for mercury is far too conservative. Some commentors recommended specific remediation goals. Other commentors stated reasons that 180 ppm is too low.

Comment: Fred Maienschein said the current remediation goal is too conservative and submitted a list of scientific articles that support increasing the remediation goal. Maienschein agrees it is necessary to be conservative, but said DOE is extremely conservative without indicating how conservative the proposal actually is. In the public meeting, Maienschein proposed a remediation goal of 2,600 ppm, which would provide a safety factor of 50,000 to 100,000. John and Kathleen Shacter expressed support for Maienschein's position. (028564, PM01, PM19, 028453)

Comment: Alfred Brooks recommends that, for risk management purposes, the oral absorption factor be set at the site-specific value of 0.01 (1 percent) and the corresponding soil remediation goal be set no lower than 1,200 ppm except in areas showing exceptionally high bioavailability. Brooks supported his position with a petition containing 13 signatures. He further stated that, in his professional opinion, the EPA risk assessment numbers are wrong. They provide a conservative factor of approximately 500,000 to a million, a level of security much larger than many risks associated with people's everyday lives. He also wrote, "The bioavailability factor for mercury in EFPC soils and sediments [should] be set at 5 percent, the average value of the ORNL measurements. The dermal absorption factor should be set at zero. The RGO should be set at 1,200 ppm." (028347, 028591, 028674, PM02, PM32, PM39)

Comment: William J. Wilcox said he supports a remediation goal of 1,200 ppm mercury because the 180 ppm goal was set using the solubility of mercuric chloride, which is 3,600,000 times more soluble than the mercuric sulfide believed to be in the EFPC soil. (028744, PM10)

Comment: Fred Sweeton said he advocates raising the remediation goal to at least 1,200 ppm mercury because of the very large safety factor used in setting the 180 ppm mercury remediation goal. (028768)

Comment: The Friends of Oak Ridge National Laboratory said that the proposed action level of 180 ppm mercury for soil in the EFPC watershed is too low by a factor of at least four (i.e., the remediation goal should be at least 720 ppm). (028650, PM20)

Comment: Robert W. Peele recommended following the DOE proposed plan but setting the remediation goal at about 600 ppm mercury except in any areas where more than 10 percent of the mercury is in a relatively soluble form. He wrote, "An appropriate compromise would be to choose a bioavailability percentage (like 10 percent) that bounds results for almost all samples and provide exceptions for those areas where measured bioavailability values exceed the bound. Accept 30 percent or the measured percentage in those cases. I propose basing the remediation goal on the 10 percent value." (028788, PM07)

Comment: Ellen D. Smith, Oak Ridge Environmental Quality Advisory Board, said that the human health remediation goal of 180 ppm mercury is unnecessarily conservative. However, she does support remediation in areas where the highest concentration of contaminated material exists. She states that the contamination in the floodplain and creek sediment poses no real risk to human health because the mercury is primarily in the sulfide form, which is not only low in toxicity and bioavailability, but also quite chemically stable. She further states that the mercury contamination is buried 6–12 in. deep, further reducing potential exposure. Jane Shelton submitted a letter supporting the Environmental Quality Advisory Board position. (028767, PM03, 028745)

Comment: James Johnson wrote that the 180 ppm remediation goal is too low a trigger for remedial action. "My impression is that the 180 ppm number is based on a maximum excess risk to an exposed individual of 10^{-4}. To make a comparison, one needs an estimate of the exposed population. There has been little discussion that I remember helpful in arriving at such an estimate." (028675)

Comment: Herman Weeren wrote that the proposed plan greatly overstated the risk to human health. (028563)

Comment: Murray W. Rosenthal said that the mercury concentration of 180 ppm that DOE proposes as the basis for soil removal is lower than it needs to be. He said that changing the estimate of the limiting mercury concentration from an excessively conservative value to one that is lower, but still quite conservative would seem to be prudent. (028416)

Comment: H. Richard and B. Jane Hicks said that Alternative 3 is probably overly conservative and that a large arbitrary factor has been built in to account for unknowns. (028345)

Comment: A. D. Ryon supported previous commentors that the 180 ppm mercury is too low, based on the strong evidence that the mercury exists as a very insoluble sulfide. (028820)

Comment: Ann and Douglas Macdonald agreed with other commentors that risk estimates err on the very conservative side. (028346)

Comment: Oak Ridge City Council members said they are uncertain that the proposed 180 ppm remediation goal is the appropriate cleanup threshold to achieve unrestricted future use. The council recommends a reevaluation to set the remediation goal to the highest possible level without jeopardizing human health or preventing unrestricted future land use. (028789)

Response: Many Oak Ridge citizens said that the remediation goal derived for mercury in soil is overly conservative (i.e., the cleanup concentration proposed by DOE is too low). DOE attempted to derive a scientifically valid and protective target concentration that took into consideration the best available information. A value of 180 mg mercury per kg of soil (ppm) was developed for the protection of children (the most sensitive receptor group) from direct exposure to mercury via inadvertent soil ingestion and dermal contact (DOE 1994c). The value of 180 ppm was based on an understanding of the mercury species present and bioavailability in Lower EFPC soils.

The remediation goal of 180 ppm was developed to protect against adverse noncarcinogenic effects of chronic exposure to mercury. One member of the Oak Ridge community was under the impression that the remediation goal was "based on a maximum excess risk to an exposed individual of 10^{-4}" and that a population estimate was required to make a comparison between remediation goals. This is not the case. Mercury is not a carcinogen and, according to EPA methods, the results of risk assessment for noncarcinogens are not expressed in terms of incremental or excess risk to an exposed population.

A number of factors affect the magnitude of the estimate of the remediation goal. Two factors of particular importance are the bioavailability and toxicity of the form of mercury to which receptors are exposed. A considerable amount of work was conducted by DOE and Oak Ridge National Laboratory (ORNL) to determine the nature of mercury contamination in Lower EFPC soil. The weight of evidence indicated that insoluble inorganic forms of mercury, such as mercuric sulfide, predominate in Lower EFPC. The toxicity and bioavailability of these forms of mercury are considerably less than that for mercuric chloride, the form of mercury that was used as the basis for derivation of the EPA reference dose (RfD) used in the risk assessment.

DOE and ORNL derived an alternate RfD for mercuric sulfide and submitted the results of this assessment to the EPA Environmental Criteria Assessment Office (Cincinnati, Ohio). The EPA Environmental Criteria Assessment Office reviewed the analysis and decided that data were insufficient to support the acceptance of an alternate RfD for mercuric sulfide. Given that receptors are potentially exposed predominantly to insoluble inorganic forms of mercury in Lower EFPC, not mercuric chloride, the RfD used in the risk and in the derivation of the remediation goal was very conservative. This RfD incorporated a large "safety factor" (i.e., uncertainty factor) that affords a very high degree of protection and conservatism for receptors exposed to insoluble forms of mercury. However, EPA directives did not permit modification of the RfD for mercuric chloride in the risk assessment, thus this extra degree of conservatism remains in the derivation of the remediation goal.

The bioavailability of mercury directly influences the magnitude of the dose estimates. The lower the bioavailability, the lower the dose experienced by receptors and the higher the remediation goal. Data on bioavailability were empirically derived from leaching/availability studies conducted by ORNL. The data from these studies were aggregated and statistically evaluated to determine an appropriate measure for use in deriving the remediation goal. Monte Carlo simulation was also used to explore the uncertainty surrounding the estimate of bioavailability of mercury species (DOE 1994c).

Many members of the Oak Ridge community expressed the opinion that the 30 percent estimate of bioavailability used in the derivation of the remediation goal was excessively conservative (i.e., too high). A number of individuals recommended use of a value of 0.01 (1 percent). Another member of the community recommended a compromise value of 10 percent, except in those regions of the creek where "measured" bioavailability values exceed 10 percent. Based on use of these alternate bioavailability factors, members of the community recommended remediation goals above 180 ppm; ranging to 2,600 ppm mercury.

The 30 percent bioavailability factor used by DOE corresponds approximately to the 95th percentile of the distribution (i.e., probability distribution) of possible bioavailability values for mercury in Lower EFPC. The value of 30 percent is a conservative value in keeping with recommendations made for remediation at mercury mining sites under the purview of EPA Region IX and the state of California.

In this ROD, a risk management decision has been made to use a bioavailability factor of 10 percent for mercury in Lower EFPC soils. It is important to recognize that the bioavailability of mercury in Lower EFPC is variable and has been quantified by a statistical distribution. Any bioavailability value selected represents a compromise; one which reflects an understanding of uncertainty (confidence level) surrounding the estimate. The 10 percent value corresponds to the 85th percentile of the probability distribution that was based on site-specific measurements. It results in a calculated remediation level of approximately 400 ppm (actual value is 438 ppm). The 10 percent value is a reasonable compromise that still affords considerable protection to human health. It is a more conservative value than requested by some Oak Ridge, Tennessee citizens. It is, however, scientifically defensible and sufficiently protective of the most sensitive receptor group (i.e., children) for direct contact with soils.

As recommended by Mr. Peelle, any areas shown to have higher bioavailability may be considered for a lower remediation goal.

ISSUE 2: REMEDIATION GOAL IS TOO HIGH

Some people said they are worried that some people in Oak Ridge have been affected or could be affected by contamination in Lower EFPC. They said they do not necessarily agree with others who think the remediation goal is too conservative.

Comment: Sandra Reid wrote, "This analysis is not protective of human health." (028786)

Comment: Ralph Hutchison, Oak Ridge Environmental Peace Alliance (OREPA), said that selection of the remediation goal has been based on public acceptance criteria rather than on the professional medical opinion about mercury's health impacts. (028835)

Response: The objective of the human health risk assessment was to evaluate the potential for adverse health effects associated with exposure to chemicals released from the DOE Y-12 Plant. DOE conducted a comprehensive evaluation based upon an understanding of the nature

and extent of contamination and the inherent toxicity of the chemicals of concern. The assessment closely followed EPA guidelines for risk assessment and was conducted with their concurrence and consensus.

EPA directives for the baseline risk assessment require a quantitative (numerical) characterization of the potential for adverse health effects. This baseline assessment is not an evaluation based on public acceptance or medical opinion alone. The baseline risk assessment conducted by DOE took into consideration data from past epidemiological studies. This information was reviewed and considered as part of the risk assessment. No new epidemiological assessments were conducted. The Agency for Toxic Substances and Disease Registry (ATSDR) is directed by CERCLA and SARA to perform specific public health activities associated with actual or potential exposure to hazardous substances released into the environment. At the request of private citizens, ATSDR conducted a health consultation on the mercury remediation goal derived by DOE for soil in the EFPC floodplain and determined the remediation goal to be protective of public health.

As noted above (Issue 1) and discussed in the remedial investigation, the toxicity measure (RfD) for mercury used in the risk assessment was very conservative. Use of this RfD assumes that receptors are exposed to mercuric chloride. The RfD for mercuric chloride is a very conservative value in and of itself. Given that the less soluble and less bioavailable mercury species predominate in Lower EFPC, this RfD for mercury affords an even higher degree of conservatism and protection to human health. Similarly, the exposure assumptions were conservative and designed to ensure protection of children, the most sensitive receptor.

ISSUE 3: OPPOSITION TO CLEANUP

Several people said they opposed the proposed cleanup action in general.

Comment: Ardis Leichsenring said she opposes any cleanup action specific to the Greenview Subdivision because her backyard will never be anything else except an aesthetically pleasing backyard. (028258)

Comment: Helen Waraksa said she favors no action anywhere along the creek. (028308)

Comment: James Westcott said that "at a time when government is stressing economy and eliminating unnecessary spending and waste, the DOE will indeed look very good if the creek project is placed on the back burner and nothing more is said about it." (028318)

Comment: Michael G. Finn said he opposes the proposed cleanup. However, he said he believes that if something must be done, removing only 10 percent of the 54,000 yd^3 is preferable to moving all of it. (028421)

Comment: Charles R. and Alma P. Schmitt said they favor no action except in areas where mercury contamination exceeds 1,200 ppm. (028448)

Comment: Geoffrey Gleason said that EFPC is not a problem and recommends that "no remedial action whatsoever be taken in connection with the mercury contamination of the East Fork Poplar Creek." (028673)

Comment: Daniel Axelrod said he prefers that action be delayed 10 years while mercury discharge from Y-12 continues to decrease. (028748)

Comment: J. Francis does not favor the proposed remedial action and favors leaving the land undisturbed. (028759)

Comment: Elizabeth K. Busteed said she favors no action because of little risk of leaving the mercury in place. She lives on the creek and has "no fear of the contamination." She wrote, "to spend millions of dollars for unnecessary remediation cannot be justified, especially when studies show it is not a great risk." (028834)

Comment: Ann and Douglas Macdonald said they oppose the remediation of the creek and think that too much money has been spent already on an unnecessary project. (028346)

Response: The CERCLA legislative process requires that a baseline risk assessment be performed during the remedial investigation. This baseline risk assessment determines the risk to human health and the environment if no cleanup action is taken. The DOE completed a baseline risk assessment for Lower EFPC. The results indicate that an unacceptable risk to human health and the environment would remain if no cleanup action were conducted. Based on this assessment, CERCLA mandates that DOE conduct a cleanup action to reduce the mercury contamination to acceptable risk-based levels. In addition, ATSDR concluded in a health consultation that in some locations along EFPC mercury levels in soil pose a threat to public health, especially to children who play along the creek's floodplain.

DOE has reevaluated the original remediation goal of 180 ppm of mercury and has recommended to the EPA and to the TDEC that the remediation goal be raised to 400 ppm mercury. If this new remediation goal is approved, the volume of excavated soil will be reduced

from 54,000 yd^3 to approximately 10,000 yd^3. The number of discrete areas along the Lower EFPC floodplain requiring cleanup will be reduced from six areas to two—the areas commonly referred to as the Bruner's Center Site and the NOAA Site. This eliminates the Greenview Subdivision and three other areas. The increase in the remediation goal also decreases the cost of the cleanup action by about $30 million. Delaying the required cleanup for any period of time would result in increased project costs and would further deny affected property owners the unrestricted use of their land.

ISSUE 4: FURTHER STUDIES OR MONITORING NEEDED

Several people said further studies and/or monitoring are needed to better characterize the site, better understand the effects of mercury on humans, and confirm the protectiveness of the remediation action.

Comment: Linda Ewald said that "we need to know really what is here and how much and where before making a firm decision." (028746)

Comment: Alfred Brooks wrote that the EFPC feeding studies should be repeated in a preferred species (e.g., pigs as suggested by ATSDR), monitoring of EFPC should be continued to assess any changes in trends significant to human health, and the movement of mercury in environmental food chains be studied further. Brooks made similar recommendations at the public meeting. (028347, PM02, PM34)

Comment: William Wilcox suggested in his letter that some of the taxpayer's money be spent to obtain a direct measurement of the toxicity [reference dose] of mercuric sulfide with rats or other animals. He urged use of pure mercuric sulfide and not an EFPC soils mixture. Such a study "could put future remediation projects on a sounder footing and help assure that scarce environmental dollars are spent where they are most needed...." He made similar comments at the public meeting. (028744, PM10, PM16)

Comment: James Phelps said he is concerned that "the Scarboro community is worthy of careful study to determine if it has any affected population due to releases from mercury and other pollutants." He also commented on possible damage involving mercury and radionuclides. He also urged that a recent fish kills in EFPC be explored. (028742)

Comment: Sandra Reid said that "...we do not know the extent of the damage on human health because no one has done the clinical examinations of these individuals who live around

these sites to find out what has happened." She said that it is DOE's responsibility to prove that the contaminants in Lower EFPC have not been detrimental to the health of the community, and not the community's responsibility to prove that it is dangerous. (028786)

Comment: Ralph Hutchison, Oak Ridge Peace Alliance, said that "whatever course of action DOE chooses at the present, it must make a commitment to revisit the decision at points in the future, perhaps every five years, or perhaps on an expanding scale- 5, 10, 20, 30, or 50 years in the future." (028835)

Hutchison said he is also concerned that DOE develop additional information on the forms of mercury and other contaminants and the effects on human and ecological health of mercury; DOE should invest in research and development of technologies designed to address contamination in the environment. He also echoed Sandra Reid's concern that DOE should conduct a clinical evaluation of populations likely to have been impacted by mercury contamination.

Response: The Lower EFPC OU is one of the most intensively studied mercury sites in the U.S. In addition to a two-phase sampling effort involving approximately 4,000 samples, DOE conducted several special studies on mercury speciation, wetlands, bioavailability, sediment bioassay, etc. Even though the argument can be made that we don't know everything, there is sufficient information to make an informed decision under the CERCLA decision process.

The remedial investigation/feasibility study process, by necessity, is based on estimations and assumptions. The information gathered and processed in the remedial investigation and risk assessment has been deemed sufficient by the regulatory agencies to determine the risk to human health and the environment from contamination present in the Lower EFPC and its 100-year floodplain.

Regarding additional laboratory animal studies and derivation of an alternate reference dose for mercuric sulfide, DOE does not believe the time delay in conducting such a study is justified. Existing laboratory studies were used by DOE to argue for an alternate RfD with EPA earlier in the process. EPA recommended that bioavailability factors be examined. This was done, resulting in a substantial increase in the remediation goal. Further, evaluation of pure mercuric sulfide would not be particularly useful for Lower EFPC because the mercury occurs in several forms, albeit primarily mercuric sulfide and elemental mercury.

Some comments suggested that clinical studies be done to determine what may have happened to people, including those residing in the Scarboro community. Studies of the potential

health risk from human exposure to mercury contamination from past DOE operations have been conducted by the Center for Disease Control, the Tennessee Department of Health and Environment (Rowley 1985), and the University of Michigan (University of Michigan 1987). These studies have concluded that residents exposed to contaminated soil are not likely to be at an increased risk of having significantly high mercury levels and that mercury contamination had not resulted in any clinical problems. DOE used these studies in the CERCLA process. The studies are available at the Information Resource Center.

Additional health studies are currently underway to address these concerns. The Tennessee Department of Health is conducting Oak Ridge health studies to find out if adverse health effects may have occurred in people as a result of past DOE operations. The Tennessee Department of Health is currently conducting a dose reconstruction study on past mercury releases from the Y-12 Plant. The commissioner of the Tennessee Department of Health has appointed the Oak Ridge Health Agreement Steering Panel (ORHASP), a group of experts and area citizens, to guide and oversee the studies. DOE is providing requested information and data to support the state of Tennessee with the Oak Ridge health studies.

In addition, at the request of private citizens, ATSDR has conducted health consultations to evaluate public health issues related to the current contamination in EFPC and the remediation goal derived by DOE. ATSDR will also be holding a science panel meeting to develop technical papers on current methods for determining the bioavailability of mercury compounds in soil matrices and on the development of a standardized site-specific soil bioassay protocol for determining the bioavailability of mercury in soil. Finally, DOE and EPA have, on several occasions, explained at public meetings that the risk assessment process used under CERCLA focuses on determining a remediation goal (cleanup level) which will be protective once implemented; it does not focus on the probabilities of past harm. In the risk assessment process, multiple contaminants are considered and the effects of these multiple contaminants are assumed to be additive.

ISSUE 5: TRAFFIC AND CONSTRUCTION RISKS AND CONCERNS

Many who attended the public meeting or who submitted written comments said they were concerned about increased truck traffic, related transportation risk, and risk to construction workers or the community during remediation. People wanted to know how the risk associated with the increased truck traffic compares to the risk associated with leaving the contaminated soil in place. They also asked what safety measures would be used during remediation to prevent accidents and spills.

Comment: Michael Finn wrote that the thousands of heavily loaded trucks on the highway may contribute more risk than leaving the soil in place. (028421)

Comment: Fred Maienschein wrote that the wildlife in EFPC is in more danger from bulldozers during remediation and subsequent development after cleanup is completed (than from the contamination). (028564)

Comment: Patty Dyer said she agreed with concerns that the traffic hazard is the greatest risk of this project. (PM05)

Comment: Herman Weeren asked what methodology was used to weigh a traffic death against cleaning the creek to protect wrens or worms. He asked how the decision was made to protect wrens and worms instead of the public. Weeren said that his primary concern was with the traffic hazard imposed by all of the enormous dump trucks barreling down the highway and what happens to him if he happens to be in the way. (028563, PM04)

Comment: James Johnson asked for a satisfactory comparison of the risks of bulldozing and trucking the soil versus the health risks of leaving it alone. He said that the 180 ppm number is based on a maximum excess risk to an exposed individual of 1×10^{-4}. (028675)

A commentor at the public meeting asked if the risk to the safety and health of the construction workers from typical construction site activities has been calculated. Another commentor asked if the risk to the public from traffic disruption had been calculated. (PM35, PM36, PM37)

Comment: Sidney P. duMont III wanted to know what safety measures are proposed to protect the citizens and drivers of Oak Ridge from the increased dump truck traffic. He also wanted to know if the dump trucks would be covered and escorted in small caravans. (028439)

Comment: Charles R. and Alma P. Schmitt said that excavation and trucking the soil would represent a transportation hazard in itself. (028448)

Comment: Fred Hannon said that DOE should "draw parallels from the time that the soil was moved from the Civic Center up on the hill." (PM18)

Comment: Elizabeth Peelle suggested using "low-tech" solutions instead of using bulldozers and dump trucks. (PM21)

Comment: Sara Childs asked about the possibility of installing a signal light at the exit and entrance of the excavation areas. (PM22)

Comment: H. Richard and B. Jane Hicks asked that the total negative effects be balanced against the estimated real mercury hazard, which is not terribly serious because they and a lot of other people have handled pure mercury and had no ill effects. (028345)

Response: A quantitative comparison of risks estimated to be incurred during remediation (i.e., due to activities such as construction and additional traffic) and risks due to leaving the mercury-contaminated soil in the floodplain is not possible.

The chances of injuries and fatalities during remediation were calculated based on U.S. Department of Transportation statistics. Sections 5.3.1 through 5.3.7 (Short-Term Effectiveness)in the feasibility study (DOE 1994b) contain brief discussions of community protection and remediation worker protection (see "physical hazards" portion). In these sections, for each of the seven alternatives (as presented in the proposed plan), the risk of transportation accidents to these two groups is estimated. These estimates are listed in Table 2.1 in the Decision Summary of this ROD. For Alternative 3, the feasibility study estimates a 0.2 percent chance that one worker will be injured and a 0.1 percent chance that one worker will die as a result of transportation activities. It also estimates a 5.2 percent chance that one person in the community will be injured and a 0.3 percent chance that one person will die as a result of transportation activities. The feasibility study further estimates that five injuries will be incurred by workers due to construction activities and a 3.8 percent chance that one worker will die as a result of construction activities.

In contrast, the chances of adverse health effects caused by leaving the mercury-contaminated soil in place (i.e., by not remediating), a noncarcinogen, cannot be calculated. The 1×10^{-4} maximum excess risk mentioned by one commentor applies only to carcinogenic (cancer) risk. Below a specific dose, noncarcinogens do not induce any adverse health effects in exposed populations. That specific dose is defined as the reference dose. Risk due to exposure to noncarcinogens is quantified through the hazard index. The hazard index is simply the ratio of the chronic daily intake of a chemical to that chemical's reference dose. A hazard index greater than 1 would indicate that the chronic daily intake is greater than the reference dose, but it in no way quantifies the probability of inducing an adverse health effect (LaGrega et al. 1994).

The risks incurred during remediation can be qualitatively compared to the risks of leaving the mercury-contaminated soil in the floodplain. This comparison is illustrated in Chapter 6 of

the feasibility study (DOE 1994b) and in the proposed plan (DOE 1995b). The discussion on "short-term effectiveness" corresponds to the risks incurred during remediation. The discussion on "long-term effectiveness and permanence" corresponds to the benefits achieved by remediating the mercury-contaminated soil as compared to the baseline risk assessment found in the remedial investigation (EPA 1994a) and summarized in the feasibility study (EPA 1994b). DOE's preference for Alternative 3 is based on a balance between short-term effectiveness and long-term effectiveness. DOE believes that Alternative 3 provides the best balance between risks incurred during remediation and risks incurred by leaving the mercury-contaminated soil in the floodplain. DOE also believes that human health and the environment would be protected adequately during implementation of the remedial alternative.

DOE appreciates the public's recommendations for reducing transportation and construction hazards. Safety measures, generically referred to as "best management practices" in the Decision Summary, will be used during implementation of any remedial action. Exact measures will be specified during the remedial design phase. They may include such actions as using alternative construction equipment (i.e., using "low-tech" solutions), constructing new roads, installing temporary signal lights in high-traffic areas, covering the dump trucks, and escorting the trucks in small caravans. DOE will also review the procedures followed when moving soil from the Civic Center to determine what lessons learned from that activity apply to excavation and transportation of the soil in the Lower EFPC floodplain.

ISSUE 6: REMEDIATION IS TOO EXPENSIVE

Many people at the meeting criticized costs associated with implementation of Alternative 3 or the cost of the entire project of remediating the mercury contamination in the soils near Lower EFPC. Others said that remediation levels for Alternative 3 are too low and that money could be saved by raising them. Two commentors suggested that the money saved from raising remediation levels could be well used on other remediation sites. Other commentors said that the benefits of implementing Alternative 3 should be weighed against these deleterious effects. Several said remediation is a waste of money.

In general, these commentors said that the cost of implementing Alternative 3 outweighs the benefits. Specific comments are listed here.

Comment: James Ed Westcott wrote that no remediation should take place at all along EFPC. (028318)

Comment: Murray W. Rosenthal and Fred Sweeton said that spending too much on one remediation project could effectively reduce the amount of money available for other such projects, thereby increasing the overall risk to the public and the environment. (028416, 028768)

Comment: Charles and Alma Schmitt wrote that they consider Alternative 3 a waste of money and based their opinion on mercuric sulfide not being a health hazard. (028448)

Comment: William Fulkerson, Friends of ORNL, said that, because the remediation goal should be four times higher than it is, implementation of Alternative 3 will waste an enormous amount public funds. (028650)

Comment: Geoffrey Gleason wrote that the mercury contamination of EFPC is not a hazard and that to spend additional funds on it cannot be justified. (028673)

Comment: William J. Wilcox, Jr. wrote, "Can't you adequately protect us and our environment by spending less money [by remediating to a higher level]?" (028744)

Comment: Elizabeth Busteed wrote that to spend millions of dollars for unnecessary remediation cannot be justified. She added that too much money has already been spent. (028834)

Comment: Fred Maienschein said he estimates the cost associated with "unnecessary conservatism" is $50 million. (PM01).

Comment: Ellen Smith said that DOE could purchase the affected land at fair market value and it would be much cheaper than Alternative 3. (PM03)

Comment: Fritz McDuffie asked, "Why will it cost $3,000/yd^3 to move all the dirt?" (PM09)

Comment: One of the cards anonymously submitted at the public meeting objected to the massive expenditure of money on risk assessment with a confidence level of essentially zero. (PM33)

Response: DOE realizes that the remediation of the Lower EFPC floodplain is very expensive. However, the health, safety, quality control, and regulatory requirements for dealing with contaminated substances (i.e., mercury-contaminated soil) make implementation of a remedial action expensive compared to, for example, excavating a residential basement.

Several commentors said Alternative 3 was too expensive due to unnecessary conservativism in the remediation goal. As discussed in the Decision Summary and in the response to comments under the "Remediation goal is too low" issue, the remediation goal has been increased, thereby substantially decreasing the cost of implementing Alternative 3.

Other commentors said that remediation of the Lower EFPC floodplain is not worth the high cost. As discussed in the response to comments under the "Opposition to cleanup" issue, remediation is required to protect human health and the environment. That the cleanup has not been activated sooner is a function of the CERCLA process.

The comparison of alternatives in the feasibility study (DOE 1994b) and in the proposed plan (DOE 1995b) documents the balance between the benefits and costs of remediation for each of the alternatives considered (including Alternative 7, which included DOE acquisition of real estate rights). The site was prioritized and funds were made available for its cleanup when the EPA and the state of Tennessee reviewed the FFA (DOE 1992) for the ORR. Any money saved could be used for other DOE remedial action projects.

ISSUE 7: CONCERN ABOUT OTHER CONTAMINANTS, CUMULATIVE EFFECTS, AND CONTAMINATION IN OTHER AREAS

Several people asked if other contaminants, cumulative effects of contaminants, and contamination in other areas were considered.

Comment: Sandra Reid said she was concerned that only mercury was being considered and that "multiple other contaminants, including uranium, volatile organic compounds, arsenic, and chlordane, and their combined hazardous effects on the environment and human health" be considered. She also said that "pregnant women and their fetuses are the most vulnerable, particularly to atmospheric mercury, radiation, heavy metals, and volatile organic compounds." She asked, "Why was only mercuric sulfide/chloride considered?" and said that fruit and vegetable pathways of exposure were not considered. She indicated that a study had shown tree rings that contained 3,000 ppm mercury and uranium uptake was significant. She asked that the significant amounts of material generated by the Y-12 Plant be considered. (028786)

Comment: Ralph Hutchison, OREPA, said, "The feasibility study does not adequately address contaminants other than mercury. During Y-12's years of peak production, significant amounts of other contaminants, including uranium, PCBs, other metals, and organic compounds are known to have been released into the air and water. Any attempt to address environmental restoration must examine the presence and remediation requirements of each individual

contaminant and all contamination taken as a whole." He said that the feasibility study must consider other contaminants and must consider cumulative impacts of the variety of contaminants. Hutchison is concerned with synergistic effects of multiple contaminants found in EFPC. (028835)

Comment: Herman Weeren recalled that the data from the Hines Creek area, intended as the control area, indicated that it was the most toxic of the areas sampled. He asked about the implications of this and if it needed to be remediated also. (PM26)

Comment: John Williams said he was concerned about a fire vaporizing the mercury in the soil and thus exposing the public to air borne mercury. He also asked about the relationship of mercury and uranium in the soil. (PM30)

Comment: An anonymous comment at the public meeting indicated concern with arsenic and radioactive contamination and their bioavailability in plants (PM45). Another anonymous commentor asked if multiple contaminants, synergism, and cumulative exposure had been considered. (PM49)

Response: Several chemicals were evaluated and cumulative impacts were determined for the Lower EFPC site. The baseline human health risk assessment used a tiered or phased approach. This three-tiered approach is explained in some detail in the ROD. In tier one, a screening-level assessment was performed on 182 chemicals, including metals, organics, and radionuclides. The assessment took into consideration the various historical effluents from the Y-12 Plant and was intended to be comprehensive for the Lower EFPC site. This concentration-toxicity screening approach reduced the number of contaminants requiring evaluation as "contaminants of potential concern."

During the initial screening of Lower EFPC soil contaminants, eight inorganic compounds, pesticides and PCBs, some polycyclic aromatic hydrocarbons (PAHs), and uranium were found to be elevated in soils. The toxicity of the contaminants of potential concern were considered to be additive because of the lack of data on the toxicity of multiple contaminants.

Additional evaluation ruled out all of these contaminants except mercury. The pesticides, PCBs, and PAHs observed in the Lower EFPC media did not substantially contribute to the estimated risks to human health. Risks associated with exposure to radioactive uranium fell within the EPA target range in all cases. Contaminants driving the elevated risk estimates in the baseline human health risk assessment include the inorganic compounds Hg, As, Be, and Mn.

Because mercury was by far the major contributor to risk of these contaminants, it was ret... as the chemical of concern for human health. A similar screening process was used for biota, also resulting in mercury as the primary contaminant of concern in soils.

In surface water and sediment, multiple contaminants were also analyzed. It was recognized that contaminants in surface water that are currently coming from the Y-12 Plant are best addressed at the plant and not as part of the Lower EFPC remediation. Mercury and PCBs were the major elevated contaminants in sediment. Mercury concentrations in sediment are not high enough to cause direct toxicity in sediment, and aquatic biota do not contain mercury levels high enough to be associated with toxicity, so the only potential for harm to the environment is through the aquatic food chain. The contribution of mercury from sediment to surface water exposure was modeled (because releases from sediment could not be measured directly) and appears to be at least two orders of magnitude below the observed concentrations. Therefore, sediment mercury appears not to be a major contributor to mercury body burdens in aquatic biota. Most of the PCB is found in sediments north of the Oak Ridge Turnpike and downstream of the Tennessee Valley Authority substation at the intersection of Illinois Avenue and the Turnpike, suggesting that the transformers at the substation, not the Y-12 Plant, were the most likely source. Ongoing efforts at the Y-12 Plant are improving conditions in the upper reaches of the creek.

Synergism was considered in the ecological risk evaluations. The principal toxic form of mercury is methyl mercury, whose mode of action is different from metal salts, so other metals could not interact with it. Several combinations of metals have been shown to interfere with rather than potentiate each others' actions, so it was more conservative to consider the inorganic compounds individually. None of the other potential contaminants of concern were known to act synergistically.

Areas such as Hinds Creek, near Norris, and Mill Branch, well upstream of its confluence with Lower EFPC, were investigated as reference areas. Findings indicate that any type of environmental investigation is unnecessary.

In the ROD, DOE, EPA, and TDEC have committed to monitoring this OU.

ATSDR concluded in the EFPC health consultation (April 1993) that only mercury in soil and PCBs and mercury in fish are at levels of public health concern. In addition, ATSDR stated concentrations of contaminants in the shallow groundwater are a public health concern, but the groundwater is not used for drinking water or other domestic purposes and does not pose a threat

to people who receive drinking water from the municipal water supply. ATSDR concluded that other contaminants, including radionuclides found in the soil, sediment, surface water, and fish, were not at levels of public health concern.

ISSUE 8: ALTERNATIVE 3 AND/OR IMMEDIATE ACTION ALTERNATIVES ARE THE MOST ACCEPTABLE

Several people said that remedial action should begin and be completed as soon as possible, at least for the areas of highest contamination.

Comment: James Harless said, "There is no better time to remove this material from EFPC" since "not much time need pass for parts or all of these expensive studies to be out of date." He said he does not want a few critics to be able to block some significant real toxic material removals that are aimed at making this as safe a community as current knowledge and experience seems to support. He wrote, "We owe it to future Oak Ridge residents, current and downstream residents, and to taxpayers in general, to take a cleanup action based on 180 ppm mercury, or on a number reasonably close to this level. We did not spend all this time and money to get all dressed up so we could be told we have no place to go." (028621)

Comment: Landowners Wayne Clark and Melvin Sturm said they are concerned about the financial losses they are suffering so long as they are not able to develop their properties. (028732, 028766)

Comment: Amy Fitzgerald, ORR Local Oversight Committee, said she is concerned that funding may not be available to complete the project if additional studies are conducted to raise the remediation goal and remediation is not initiated according to the current schedule. (028769)

Comment: The Oak Ridge City Council "urges the DOE to commence and complete remediation activities at the earliest possible opportunity." (028789)

Comment: Robert Peelle said, "We should follow roughly the plan DOE has prescribed, the so-called Alternative 3, removing and replacing the contaminated soil." He said, "Administrative controls like fences won't last, soil treatment seems very problematic, capping seems very temporary in the course of generations because the creek will most likely...meander in the floodplain." (PM07)

Response: Alternative 3, the alternative put forth in the proposed plan (DOE 1995b) and presented at the public meeting, is the selected remedy. The remediation goal has been increased

to 400 ppm mercury, thereby changing the magnitude of some of the components of the alternative, but not otherwise changing the alternative. Some studies are ongoing or planned, but remediation will not be delayed as a result of those studies. Remediation must be initiated within 15 months of the approval of the ROD.

ISSUE 9: REMEDIATION SHOULD FOCUS ON THE AREAS OF HIGHEST CONTAMINATION

Several commentors said that the areas of highest contamination ("hot spots") should be removed. Some said that only these areas need to be excavated.

Comment: Ellen Smith said that the layers of "black goop" seem to have the highest concentrations of mercury and that it would make sense to clean up the identifiable concentrated deposits. (PM03). She also wrote, "It should be possible to selectively remove the visually identifiable concentrated layers of contamination using excavation equipment (scrapers?) that would enable stripping of discrete soil layers, in order to separate relatively clean soil layers from those with significant contamination." (028767)

Comment: Ricky Williams suggested spot cleanup so that a smaller total volume of soil is ultimately excavated. (PM17)

Comment: Elizabeth Peelle suggested a "tailored, low-tech way" of removing the "most contaminated stuff" and keeping open the option of more detailed cleanup later. (PM21, PM41)

Comment: Ralph Hutchison, OREPA, recommended that DOE immediately remediate "those few small areas which present significant mercury contamination (> 300 ppm)" and store the soil until it can be treated or disposed of. (028835)

Comment: Mayor Edmund Nephew recommended targeting excavation efforts on the selective removal of the visually identifiable soil layers that have been correlated with significantly elevated contaminant concentrations. (028789)

Response: Soil at only two sites, the NOAA site and the Bruner's site, contain levels of mercury above the remediation goal of 400 ppm. Excavation will occur only at those two sites.

There is a dark-colored band of soil which often contains high concentrations of mercury. However, there are soils with mercury concentrations above 400 ppm that are not distinguishable by color.

Because of the heterogenous distribution of mercury in soil, both horizontally and vertically, excavation of selected, narrow bands may not remove all of the mercury above the selected cleanup level. Even if it were possible to always isolate mercury contamination to a discrete layer in the soil, there are real world problems of recognition and actual physical removal. It would be very difficult with any type of equipment to get the separation desired at a reasonable cost and in a reasonable time.

Using hand shovels would require a longer time to remove the areas of high mercury contamination than using standard construction equipment because roots and trees must be removed and a layer of clean soil often covers the contaminated soil to be excavated.

The mercury contours in the maps in the remedial investigation (DOE 1994a) and the feasibility study (DOE 1994b) are estimates of the suspected location of mercury above a certain level. The contours are based on finding mercury above a given concentration (during the Phase Ib sampling of the remedial investigation) and interpolating that concentration based primarily on topography. Thus, during the actual remediation, confirmatory sampling will be conducted to establish the exact location of the higher mercury concentrations and to confirm that all soil contaminated with mercury above 400 ppm has been removed.

ISSUE 10: EROSION AND RECONTAMINATION

Comment: Sidney duMont asked if the differences between soil erosion impacts of replacement of contaminated soil with borrow soil versus treatment of contaminated soil and backfill with that original soil had been considered. He also asked about the impacts of erosion of soils from the borrow area and from the landfill. (028439)

Comment: Linda Ewald said that excavation and trucking of the soil may "make the situation worse by stirring up and spreading the contamination and damaging the environment." (028746)

Comment: Ardis Leichsenring said she was concerned that trees would be cut, "leaving the land nude." (PM08)

Comment: A card anonymously submitted at the public meeting asked, "What is the point of removing some of the contamination when the Y-12 Plant could still recontaminate the creek?" (PM44)

Response: After remediation, each excavated site would be restored by grading the land surface to its original contour, stabilizing the site to prevent erosion, and revegetating the site to ensure long-term stability of the soil surface [see page 5-63 of the feasibility study (DOE 1994b)]. A specific comparison between backfilling with borrow soil versus treatment of the contaminated soil and backfill with that original soil was not considered. However, erosion effects of backfill material and treated soil were considered in the feasibility study (DOE 1994b).

Recontamination of the soils is not expected. The contamination of the floodplain soils occurred during the 1950s and 1960s. The processes in use at that time have been discontinued and the current residual releases of mercury from the Y-12 Plant are minimal and decreasing. As part of the remedial design, an Erosion Control Plan will be written. Following good management practices during cleanup of upstream areas would prevent any appreciable contamination from migrating downstream.

Contamination of sediments by sloughing of stream-bank soil containing high levels of mercury was also examined in the feasibility study (DOE 1994b). The predicted downstream concentrations in the sediment are less than 100 ppm. This model result is consistent with observed sediment concentrations, which have always been below 100 ppm.

ISSUE 11: LANDFILL AND ASSOCIATED OPERATING COSTS

A few comments had specific concerns related to the proposed landfill at the Y-12 Plant, into which excavated contaminated soil would be deposited under Alternative 3.

Comment: Sidney duMont, in a written comment, asked about the erosion of soils from the proposed landfill. He also asked if there was any chance DOE would later be forced to treat the contaminated soil placed in the landfill because of the leachability of contaminants or other performance issues. (028439)

Comment: Harry Francke and Ricky Williams asked, "What will the landfill look like? How will it be handled? How will the mercury be contained in the landfill? What will the effect on the groundwater be? What will the cost of ongoing care and monitoring of the landfill be for the next hundred years? Mr. Williams said he did not see any cost estimates for ongoing care of the landfill." (PM12, PM17)

Comment: Linda Ewald asked about disposal of the contaminated soil. If it is exposed to rain or buried in the ground, she said she is concerned that the contamination will eventually reach and contaminate the groundwater. (028746)

Response: The landfill used for disposal of the mercury-contaminated soil will be a lined, permitted, Subtitle D landfill with leachate collection. The liner will prevent any migration of leachate to the groundwater. The leachate will be treated, if necessary, before it is discharged. The landfill is estimated to be open for 5 years after the first load of soil from the Lower EFPC floodplain is deposited. When full, the landfill will be capped with liners and a vegetative cover.

The level of material in the landfill will always be lower than the perimeter of the landfill. Therefore, erosion of the mercury-contaminated soil in the landfill will not occur. The liners and vegetative cover will inhibit erosion after the landfill is closed.

The cost estimate presented in the feasibility study (DOE 1994b) reflects the cost of operating the open landfill for 5 years. Thirty years of post-closure care are generally required for landfills. However, the cost for post-closure care is not included in the feasibility study cost estimate for Alternative 3. DOE is evaluating whether costs associated with post-closure care are applicable to this remedial action.

ISSUE 12: REASON FOR REMEDIATION

Comment: Shannon Gorman asked, "Why did DOE make the decision to remediate?" She also asked, "What is the guiding factor and why did DOE decide that this cleanup action was necessary?" (PM28)

Response: DOE performed a baseline risk assessment as part of the remedial investigation of Lower EFPC. The results of this risk assessment indicated that an unacceptable risk to human health and the environment would remain if no cleanup action is taken. The CERCLA legislative process mandates that a cleanup action be taken if an unacceptable risk to human health and the environment is posed. Therefore, DOE has no option except to reduce the level of mercury contamination to acceptable risk-based levels.

ISSUE 13: ADVISORY SIGNS

The state of Tennessee has posted signs discouraging fishing and water contact along Lower EFPC. Some members of the public wanted these advisory signs changed to only discourage fish consumption.

Comment: Alfred Brooks, in a petition signed by 13 community members, requested that EFPC be posted against fishing only in those regions for which the levels for mercury and other toxins in fish exceed the guidelines for safe human consumption and that other restrictions on creek water contact be removed. (028674, PM02)

Comment: Richard and Jane Hicks asked for a permanent solution, which they said would allow the existing advisory signs to be removed. (028345)

Response: The advisory signs fall under the purview of the state of Tennessee. Upon completion of cleanup, the state will reevaluate the need for the advisory signs.

ISSUE 14: DOE COMMITMENT TO DECREASE MERCURY LOSSES FROM Y-12

Several residents requested a commitment from DOE to further decrease discharges from the Y-12 Plant.

Comment: Alfred Brooks and 13 members of the community signed a petition stating that DOE should continue its commitment to the cleanup of the discharges from Lake Reality and subsurface sources at Y-12. (028591, 028674)

Comment: Robert W. Peele requested that DOE include an explicit pledge to continually reduce pollution discharges from the Y-12 Plant. (028788, PM07)

Comment: Amy Fitzgerald, ORR Local Oversight Committee, said she would like DOE to make a commitment including "an explicit pledge to continue to reduce discharges from the Y-12 Plant." (028769)

Comment: Charles and Alma Schmitt said they think there is no adequate guarantee or environmental pollution controls that would prevent the Y-12 Plant from recontaminating EFPC with mercury, radioactive substances, or other toxic pollutants. (028448)

Response: DOE is committed to decreasing mercury losses from the Y-12 Plant. The potential for substantive mercury releases from the Y-12 Plant is minimal in that neither production activities nor processes that used mercury are operative now. The source of contamination is outside of the confines of the Lower EFPC OU and are being addressed by the Y-12 Plant ER Program as part of the Upper EFPC OU. Any small amounts of mercury leaving the Y-12 Plant are the result of historic deposits of mercury within the plant boundaries. To comply with the requirements of the Clean Water Act, DOE is negotiating a new National

Pollutant Discharge Elimination System permit, as required by Section 402 of the Clean Water Act. The National Pollutant Discharge Elimination System permit is undergoing final negotiation to establish effluent compliance goals, objectives, and a schedule for obtaining compliance with State instream water quality standards. As a regulated process, failure to comply with the permit requirements may result in stipulated fines and penalties. Further detailed information on the status and progress of this Clean Water Act requirement may be obtained by contacting the Information Resource Center.

ISSUE 15: NEED FOR CONFIRMATORY SAMPLING

Comment: Ardis Leichsenring asked if the contaminated areas would be checked again to be sure that they contain 180 ppm mercury before they are excavated. (PM08)

Response: DOE is currently sampling to further define the contours of the soil contaminated with mercury above 400 ppm. In addition, confirmatory sampling will be conducted during remediation excavation to further delineate the soil above 400 ppm and to confirm that excavation is complete.

ISSUE 16: DESIRE FOR UNRESTRICTED LAND USE AFTER REMEDIATION

Three written comments encouraged cleanup to levels that would provide for unrestricted future land use.

Comment: Melvin Sturm, property owner, said that he would like to see his property "returned to a safe condition so that [he can] be free of restrictions." (028732)

Comment: Wayne Clark, property owner, said he hopes EPA, TDEC, and DOE will "adopt a remedy which will incorporate sufficient health-based performance criteria to protect the public, the environment, and return [his] property to a safe condition and with no restrictions on its use." (028766)

Comment: Finally, Mayor Edmund Nephew, on behalf of the Oak Ridge City Council, wrote that "the City strongly embraces this goal [of unrestricted future land use] and believes it to be a necessary outcome of any cleanup strategy." (028789)

Response: Implementation of Alternative 3 will allow for future unrestricted land use for all land use types in the Lower EFPC floodplain.

ISSUE 17: COST SHOULD DETERMINE SELECTION OF THE REMEDY

Several people said that cost should determine the choice of alternative.

Comment: W. W. Parkinson wrote that "simple economy should be the controlling factor since all alternatives protect human health adequately." (028226)

Comment: Daniel Axelrod suggested developing alternatives on the basis of cost. For example, he suggested an alternative that consists of remediating as much of the floodplain as possible for $4.5 million or $10 million. (028748)

Response: Of the nine CERCLA criteria, two are threshold criteria, five are balancing criteria, and two are modifying criteria. Only the two threshold criteria, "overall protection of human health and the environment" and "compliance with ARARs," drive the selection of a remedial alternative. In other words, those two criteria must be met to consider implementation of a particular alternative. Cost is one of the balancing criteria and, at the remedy selection stage, is only used to compare alternatives against one another.

The lowest-cost alternative evaluated, the no action alternative, is estimated to cost $12 million dollars. Therefore, no evaluated remedial alternative could be implemented for $4.5 million or $10 million.

ISSUE 18: INTERAGENCY COOPERATION

Comment: John and Kathleen Shacter wrote that they are "greatly concerned that DOE isn't in dialog with EPA...making sure that our money is not wasted." (028453)

Comment: Ray Hedrick, U.S. Army Corps of Engineers, Nashville District, said he commended DOE for the outstanding interagency cooperation. (PM31)

Response: DOE has benefitted greatly from constant interagency communication regarding technical and program management issues that serve as the focus of the dialogue among EPA, the state, and itself. In particular, EPA has served a valuable role by providing the resources of their national laboratories to review and evaluate technical approaches and studies. For example, before the use of the mercury chemical speciation data, DOE used EPA's standard risk assessment guidance to determine a cleanup level protective of human health. One hundred per cent adsorption of the mercury exposure was assumed, resulting in a human health cleanup level of 50 ppm (mercury). However, after networking, DOE found that the use of the absorbed

dose concept had been employed recently at two CERCLA sites in EPA Region IX (California). The modified risk assessment that resulted from the chemical speciation and absorption studies was used in the feasibility study addendum and resulted in raising the proposed human health cleanup level to 180 ppm. In response to public comments and more site-specific supportive data, EPA has concurred that a cleanup level of 400 ppm will be protective of human health for this site. The results of these technical interactions have saved over $130 million in remediation costs at this writing.

ISSUE 19: PUBLIC INVOLVEMENT IN THE DECISION TO CHANGE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT/NATIONAL ENVIRONMENTAL POLICY ACT INTEGRATION

Comment: Ellen Smith, Environmental Quality Advisory Board, said she is concerned that since DOE policy changed with respect to writing a feasibility study incorporating National Environmental Policy Act (NEPA) values instead of writing a feasibility study-environmental impact statement, the public would no longer have the opportunity to comment on the feasibility study. Ms. Smith said she would have appreciated notification of the opportunity to comment on withdrawing the notice of intent to prepare an environmental impact statement for this project. (028767)

Response: DOE advised the public of its revised NEPA policy in a mailing sent to more than 1,500 stakeholders. In the mailing, DOE solicited public opinion on withdrawing the notice of intent for NEPA. DOE did not receive any adverse comments on the proposed feasibility study. Nonetheless, the feasibility study fully addresses all NEPA values.

In addition to the public being asked to comment on the proposal to change the approach in dealing with NEPA, DOE followed a 45-day public comment period on the proposed plan, which is consistent with a NEPA review period for a Draft Environmental Impact Statement, rather than a 30-day period, which is consistent with CERCLA. DOE also indicated that comments on the proposed plan and supporting documents (such as the feasibility study and the remedial investigation) would be addressed in the Responsiveness Summary, so the public had opportunity to comment on the full range of information available.

ISSUE 20: NATURAL RESOURCE DAMAGE ASSESSMENT APPLICABILITY

Comment: Vickie Brumback asked if the city of Oak Ridge could receive Natural Resource Damage Assessment funds to be used for other purposes if a lower cost alternative were selected. (PM24)

Response: The Natural Resources Damage Assessment process is performed after a response action to assess residual damages. Residual damages are those injuries to natural resources that were not addressed by remedial actions. The damage assessment is the process the trustees of natural resources (e.g., the U.S. Fish and Wildlife Service) use to determine the amount of monetary damages a trustee may pursue in a CERCLA action as compensation for injury to natural resources, or for the cost of mitigation, restoration, or replacement of lost or injured natural resources. The money would not go to the city of Oak Ridge.

ISSUE 21: FUTURE LANDOWNER LIABILITY

Comment: Wayne Clark expressed a liability concern. He said that he owns 2,000 undeveloped linear feet of the Oak Ridge Turnpike and EFPC. He said that, if in the future he seeks to develop his land and then he's taken to court by a person making a claim, DOE should assume the legal responsibility and hold him harmless. Mr. Clark also asked who would be liable if future requirements indicate that the present cleanup level is too high and further remediation is required. (PM15)

Response: DOE assumed the role of Potentially Responsible Party pursuant to CERCLA; Should further CERCLA clean-up be required as a result from releases by DOE, DOE, in concert with the FFA parties, would undertake the remediation in accordance with CERCLA, NCP, and the FFA.

ISSUE 22: EFFECT OF A FIRE IN THE FLOODPLAIN

Comment: John Williams asked whether DOE, EPA, and the state of Tennessee considered the scenario of a fire in the floodplain with potential volatilization of hydrogen sulfide where concentrations of hydrogen [mercuric?] sulfide are less than 180 ppm. (PM06)

Response: While soil temperatures become elevated during a fire, they do not exceed 200°C (390°F) 2.5 cm (1 in.) below the soil surface (Barbour et al. 1980). The change in soil temperature is a function of the thermal conductivity of the soil and the temperature and duration of the fire. The rate of heat transfer is affected most by the amount of soil moisture. Temperatures will not rise above 100°C (212°F) until all water evaporates.

Treatability studies showed that the mercury species in the Lower EFPC floodplain soils volatilize in the temperature range of 250–650°C (480–1,200°F) (DOE 1993). In addition, the majority of the mercury in the Lower EFPC floodplain soil is buried under more than 2.5 cm

(1 in.) of soil, and the soils have a very high moisture content. For these reasons, volatilization of mercury would be negligible, even during very intense fires such as forest fires or fires used to clear land for development.

ISSUE 23: PROCEDURE FOR CHANGING THE REMEDIATION GOAL

Comment: Bill Burch asked if it is possible to change the remediation goal (i.e., what the procedure was to change it). (PM13)

Response: It is possible to change the remediation goal. In fact, this ROD reflects an increase in the remediation goal. Alternative 3, as presented at the public meeting, was based on a remediation goal of 180 ppm mercury. Through the risk management process, the remediation goal has since been increased to 400 ppm based on less-conservative risk assumptions and additional risk calculations. The remediation goal of 400 ppm is protective of human health and the environment.

ISSUE 24: ECOLOGICAL CONCERNS

One commentor expressed support of the remediation plan despite short- to intermediate-term loss of habitat. Several commentors said that the apparent ecological risks in the EFPC floodplain are less than indicated by the feasibility study. They expressed concerns that the remediation goal of 180 ppm is too low and that cleanup would do more damage to the environment than it would benefit the resident plant and animal populations. On the other hand, some commentors said that the remediation goal is not sufficiently protective of plants and animals.

Three commentors criticized the content of the ecological risk assessment. Some comments reflected an impression that the feasibility study deals with exposures to EFPC surface water as well as floodplain soils and that DOE is responsible for evaluation and remediation of non-DOE sources of contaminants.

Comment: Amy Fitzgerald, Local Oversight Committee, said she generally supports the selected remedy. She said that wetlands compensation could help offset the loss of wetlands caused by remediation and that habitat restoration will probably occur in the not-too-distant future. (028768)

Comment: Ann and Douglas Macdonald said they do not want the Greenview area remediated. They said that the birds and animals are plentiful and do not seem to suffer from toxic effects. (028346)

Comment: A. D. Ryon said that the ecological remediation goal of 180 ppm is too conservative and that habitat destruction resulting from remediation would be more damaging than the existing exposures. He said that Florida has a mercury problem—not Oak Ridge. (028820)

Comment: James Ed Westcott said he is concerned that cleanup will destroy natural habitats, which will require years to recover and that EFPC "may never return to its natural state." (028318)

Comment: Geoffrey Gleason said that mercury levels in biological specimens do not indicate significant exposure to mercury. He said that concentrations of mercury in canned tuna (analyzed between 1983 and 1987) were higher than in any biological specimens from EFPC. (028673)

Comment: James Phelps and Sandra Reid mentioned fish kills in EFPC. James Phelps said he wants the problem of fish kills in EFPC to be explored and exposed publicly, as well as interactions of mercury and radionuclides that cause damage to deoxyribonucleic acid (DNA). (028742)

Comment: Alfred Brooks said that the ecological risk assessment for EFPC addresses individuals rather than populations, does not address effects from non-DOE sources, does not balance the cost of environmental cleanup against the value of a few individual animals, does not demonstrate harmful effects to plant or animals populations, and does not demonstrate a need to harm the environment by remediating it. (028347)

Comment: Ellen Smith wrote that the ecologically based remedial goal of 200 ppm is too stringent. She said that the EFPC floodplain ecosystem appears to be healthy and diverse, so the net effect of remediation, with its attendant habitat alteration, would be "extremely negative." She wrote that it is questionable whether habitat restoration would be successful because of the lack of habitat reservoirs in the urban setting of the floodplain. She said that the remedial goal for protection of the environment should be greater than that for the protection of human health; "that is, if a higher human health goal is selected, the ecological goal should also increase to the same level or higher." (028767)

Comment: Fred Maienschein said of the ecological risk assessment, "the numbers and the quoted remediation goal are neither understandable nor apparently consistent," and the accompanying uncertainties make the remediation goal no better than an order-of-magnitude estimate. He said wildlife is thriving now but will be threatened by cleanup. He also stated that the bioavailability factor of 100 percent used in ecological risk assessment is unrealistic in light of low apparent bioavailability of mercury from floodplain soils. (028564)

Comment: Ralph Hutchison, OREPA, said that the feasibility study did not adequately address contaminants other than mercury. He said that there are significant risks to plants and animals from exposure to uranium, as documented by detectable levels of uranium in their bodies and in soil, sediment, and water. He said there are risks to aquatic life from chlordane in the soil and that the ecological risk assessment does not address cumulative or synergistic effects of contaminants on plants and animals. He further stated that DOE has not demonstrated that the distribution of forms of mercury in EFPC floodplain soils will not change in the future and has ignored the potential of mercury to inhibit the repair of radiation damage in fish.

Hutchison said that toxic effects of EFPC contaminants to plants were ignored in the ecological risk assessment, including the presence of mercury in tree cores, which he states was documented to be above 3,000 ppm. He expressed a concern that toxic effects of contaminants on contaminant-resistant plants were studied.

Hutchison further said that the impact of contamination on ecological health is either underestimated or ignored. He believes that the ATSDR health consultation should not have been restricted to evaluation of risks to humans. He said the uncertainties inherent in the ecological risk assessment were "stunning." He does not believe that a decision on protection of the environment can be made when the environment is a constant state of flux. He said that comparing the relative risks of current exposures to the potential damage caused by remediation is "outside the boundaries of recognized practice in considering environmental impacts," as described by NEPA. Hutchison said that risk managers may not have the moral authority to decide whether to remediate a site or leave its habitat intact. He said that balancing the remedial risks to ecosystems against ecotoxicity requires further discussion before it is applied, and he demanded that the ecological risk assessment be rewritten to include "recent data and cumulative impacts or multiple contaminants and to discard the 'new method'" (i.e, balancing risks in the feasibility study). (028835)

Response: The selected remedy is based primarily on protection of human health, so choice of the remedy did not rely solely on a demonstration of harmful effects to plants and animals. However, ecological risks were identified, and it is necessary that after remediation there be no unacceptable residual risks to plant and animal populations.

Numerous ecological RGOs for soil were published in the remedial investigation addendum (DOE 1994c). RGOs for four types of receptors under three exposure conditions were systematically developed. Mid-level predators required the lowest remediation goals for protection; for the lower exposure scenario, RGOs ranged from 60 ppm to ~4,200 ppm. The recommended remediation goal, 300 ppm, was based largely on site-specific assumptions and data. A previously computed RGO of 200 ppm (DOE 1994a) was selected in the feasibility study (DOE 1994b) because of its conservative exposure assumptions.

Because there were many public comments critical of the methods and results of RGO development, DOE has systematically reexamined the RGO development process (DOE 1995a). Two technical approaches were taken to extend and/or reinterpret the ecological RGOs for soil. One was to protect populations instead of each individual organism; the other was to reevaluate all of the parameters in the exposure equation.

The approach and strategy document for the ecological risk assessment on the ORR (Suter et al. 1994) states that the lowest observed concentration for dietary exposure that causes effects on avian reproduction is "the most important chronic test endpoint for ecological assessment of terrestrial effects of pesticides and arguably the most applicable" for waste sites (Suter et al. 1994). This document also states that the appropriate level of ecological protection of mid-level predators is the population rather than the individual. Thus, an acceptable degree of threat or risk to population survival at Lower EFPC should be achieved as long as the dietary exposure of individuals does not exceed the Lowest Observed Adverse Effect Level (LOAEL) for reproductive success.

The value used in the RI addendum (DOE 1994c) as the toxicity endpoint for the diet of birds was 0.2 ppm, a value based on an estimated No Observed Adverse Effect Level (NOAEL) for reproductive effects. The currently proposed LOAEL for reproduction by wrens, which is based on the LOAEL for reproduction by finches (1 ppm), was adjusted for the higher metabolic rate of wrens to a value of 0.33 ppm (DOE 1995a). A change in the dietary toxicity benchmark for mid-level predators from 0.2 mg mercury/kg diet to 0.33 ppm raises the RGO by a factor of 1.67 to 500 ppm.

The second approach, which is independent of the first, is a reevaluation of the assumed fraction of mercury in the diet of mid-level predators that is methylmercury. A very conservative value was used in the RI addendum (DOE 1994c). Data from the EFPC RI were not used because the only data available from animals were for crayfish, which are more aquatic than terrestrial and are likely to have a much higher methylmercury content than terrestrial organisms fed upon by mid-level predators. Instead, the fraction of methylmercury in birds was used in the RGO derivation (DOE 1994c). Because methylmercury bioaccumulates more in mid-level predators than in their prey, the methylmercury fraction in birds is a conservative estimate of methylmercury percentage in the diet of mid-level predators.

The RGO for mid-level predators recommended in the RI addendum (DOE 1994c) was based on the assumption that 4 percent of the dietary mercury consumed by mid-level predators is methylmercury. The number was the highest geometric mean fraction reported on a seasonal basis for sparrows at the Almaden, Spain mercury mining site (Hildebrand et al. 1980). The geometric mean fraction calculated from all data reported (DOE 1995a) was 2.5 percent. If the toxicity benchmark remains at 0.2 ppm, a dietary methylmercury fraction of 2.5 percent , which is still conservative, increases the RGO from 300 ppm to 480 ppm. Therefore, either a change in the safety factor or a change in the percent methylmercury results in a remediation goal of ~500 ppm. If both these changes are considered together, the remediation goal could be as high as 800 ppm. It is DOE's position that the revised remediation goal is conservatively protective for both human health and the environment.

Digging up contaminated soil will unquestionably alter some terrestrial habitats. However, remediation must protect human health and the environment in the long term. The proposed remediation will result in temporary destruction of small amounts of habitat that will not permanently impact ecological populations. Because the revised plan calls for only a very limited area to be excavated, a relatively small amount of habitat will be damaged. It will take a few to several decades for the habitat, including wetlands, to recover completely. The choice of the preferred alternative indicates that DOE, EPA, and TDEC consider the loss of habitat to be justified by the resulting reduction of risk to humans, plants, and animals using those parts of the floodplain. The proposed plan requires measures be taken to prevent damage to the creek as a result of excavation of floodplain soils. The revised cleanup plan calls for excavation of only a few limited areas in the floodplain, none of them adjacent to current residences.

Elevated levels of mercury were found in some biological specimens during the remedial investigation. Many biological samples taken from EFPC had mercury concentrations above

1 ppm, the current level allowed by the Food and Drug Administration for fish sold for human consumption (49 *Federal Register* 45663). The mercury problem in Oak Ridge is real, but it is clearly smaller and better contained than the problem in Florida.

The problem with fish kills has been discussed publicly in several newspaper articles. Fish kills in Lower EFPC have been caused by such things as gasoline spilled from an overturned tanker truck and solvents spilled at one of the commercial establishments near the creek. No fish kills in Lower EFPC have been attributed to DOE activities or to contaminants in the floodplain soils. Fish kills have occurred in Upper EFPC as a result of Y-12 Plant activities, but better chlorine-handling equipment installed at the Y-12 Plant has decreased their frequency. However, toxicity in Upper EFPC is not the subject of the Lower EFPC project.

The *Second Report on the Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek* (Hinzman 1993) describes studies of DNA damage (strand breaks) in fish from EFPC. The studies do not identify the cause of DNA damage because there are many possible causes of damage. The report concludes that the observed amount of DNA damage is higher in fish from EFPC, Beaver Creek, and Brushy Fork than in fish from the Hinds Creek reference site. Some EFPC samples had more strand breaks and some had fewer strand breaks than samples from Brushy Fork. The amount of DNA damage in EFPC fish generally decreased during the study period from June 1987 to August 1988. The highest amount of DNA damage was observed in fish sampled in the loop north of the Oak Ridge Turnpike, where concentrations of PCBs and some PAHs are also elevated more than at most locations nearer the Y-12 Plant. It is likely that urban runoff and commercial spills, rather than DOE activities, account for most of these elevated contaminant levels.

Impacts of non-DOE sources on biological populations were discussed in the ecological risk assessment. Effects on plant and animal populations were attributed to specific habitats, nonspecific cyclical effects on populations, and former grazing. Pesticides, PAHs, and PCBs may come from non-DOE sources, but their harmful effects are not so large as to negate the benefits to human health of cleaning up contamination for which DOE is responsible.

A special task force studied ways to balance the risks and benefits of remediation against the risks and benefits of exposure to contaminants. This task force concluded that an existing threat to human health justifies the damage to ecosystems that would accompany remediation, unless those ecosystems are protected by law (e.g., wetlands or critical habitat for threatened or endangered species). Risks from remediation were discussed in the feasibility study, and alternatives that caused the highest risks during remediation were among those eliminated from consideration. An attempt was made in Alternative 7, more than in any other alternative, to

balance the value of ecological resources against the costs and benefits of remediation. DOE, EPA, and TDEC concluded that the value of a permanent remedy was higher than the value of preventing a temporary loss of a few animals or of habitat.

Incremental changes in the ecological risk assessment resulted from the evolution of the risk assessment process during the study. Remediation goals presented to the public and described in supplemental documents [*Addendum to the East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report* (DOE 1994c) and *Remedial Goal Options for Mercury in Sediment of East Fork Poplar Creek, Oak Ridge, Tennessee* (DOE 1995a)] were developed with data that became available after the remedial investigation was completed. The wide range of RGOs presented in these supplemental documents reflects the broad uncertainties in the available data, including limited site-specific data and published exposure data. It is the responsibility of the regulators to choose what level of uncertainty fits with their policies for risk management. Therefore, a conservative remediation goal for ecological risk was chosen.

The risks from contaminants other than mercury to plants and animals were addressed in the ecological risk assessment. During the initial screening of EFPC soil contaminants, eight inorganics, pesticides and PCBs, some PAHs, and uranium were found to be elevated. The plants and animals that were sampled were analyzed to determine their whole-body burdens of those analytes. When the amounts of available tissue were limited, the analyses were done in the order presented above. The remedial investigation report presented the results of these analyses in the tissue samples as representative of the exposure of biota to the contaminants. Most of the analytes were excluded from further consideration at most sites because they were not above background levels. Mercury and cadmium, pesticides, PCBs, and PAHs were retained because their levels were elevated above background in at least one site.

Risk characterizations were done using available information about the concentrations and toxicity of the contaminants of potential concern. Mercury was retained as a contaminant of concern, but cadmium levels in soil appeared to be inadequate to cause chronic toxicity to plants or wildlife. Although detectable levels of pesticides were found in some animals, pesticides were not widespread in the biota, nor could it be shown that they originated from the Y-12 Plant. EPA has set no cut-off level for cancer rates in biota, so protection of populations from toxicity is the most suitable endpoint for PAH, PCB, and uranium exposure. The concentrations of carcinogens required for direct toxicity are much higher than those that elicit tumors, so higher concentrations of PAHs, PCBs, and uranium are tolerable for protection of animals than for humans. Therefore, cadmium, pesticides, PAHs, PCBs, and uranium were dropped and mercury was retained as the single contaminant of concern for the terrestrial ecosystem.

In surface water and sediment multiple contaminants were also analyzed. It was recognized that contaminants in surface water that appear to be currently coming from the Y-12 Plant can not be cleaned up as part of the EFPC remediation. Mercury and PCBs were the major elevated contaminants in sediment. Mercury concentrations in sediment are not high enough to cause direct toxicity in sediment, and aquatic biota do not contain mercury levels high enough to be associated with direct toxicity, so the only potential for harm to the environment is through the aquatic food chain. The contribution of mercury from sediment to surface water exposure was modeled (because releases from sediment could not be measured directly) and appear to be at least two orders of magnitude below the observed concentrations. Therefore, sediment mercury appears not to be a major contributor to mercury body burdens in aquatic biota. Most of the PCBs are found in sediments north of the Oak Ridge Turnpike and downstream of the transformer station at the intersection of Illinois Avenue and the Turnpike, indicating that those transformers, not the Y-12 Plant were the most likely source. Ongoing efforts at the Y-12 Plant are improving conditions in the upper reaches of the creek, but further changes in operations are necessary and are being planned to reduce exposures in surface water even more.

Synergism was considered in the risk evaluations. The principal toxic form of mercury is methyl mercury, whose mode of action is different from metal salts, so other metals could not interact with it. Several combinations of metals have been shown to interfere with rather than potentiate each others' actions, so it was more conservative to consider the inorganics individually. The concentrations of gamma-emitting radionuclides, which cause DNA strand breaks, were not sufficiently high in EFPC soils that inhibition of the repair of radiation-induced DNA strand breaks by mercury would be a problem.

Mercury has been found in trees in the EFPC floodplain. Ralph Turner of ORNL has found concentrations as high as 3 ppm (3,000 ppb not 3,000 ppm) in trees. He states that the location of the maximum concentrations in the cores corresponds to exposures by air or surface water in the 1950s and 1960s, with much lower concentrations in recent growth rings. Only two samples of leafy vegetation and shrub shoots, which reflect current exposures from soil and surface water, were found to have mercury concentrations above 1 ppm. No trees sampled during the EFPC remedial investigation showed mercury concentrations above 1 ppm [*Addendum to the East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report* (DOE 1994c)]. Surveys of plant populations showed the same kinds of plant species in contaminated and noncontaminated areas of the floodplain. The presence of mercury in healthy trees implies that normal populations of trees have not been selected against by the toxic effects of mercury or other contaminants. It is not harmful to the environment if individual plants are resistant to contaminants, as long as ecosystem function is maintained.

All of the requirements of EPA and TDEC were followed in preparing the ecological risk assessment for EFPC. These included problem formulation, analysis (exposure assessment and effects assessment), and risk characterization. Methods for an ecological risk assessment are not as well defined by EPA as methods for a human health assessment. Therefore, the site-specific approach and methods to be used for the EFPC environmental risk assessment were discussed with and approved by EPA and TDEC before the work began. ATSDR did not advise DOE on methods or toxicity values for ecological risk assessment because ecological effects are beyond that agency's scope.

At many points during the process, meetings and teleconferences were held with EPA and TDEC to ensure that the risk assessment was being performed in accordance with general and site-specific EPA guidance. The result was a document of over 500 pages that was more detailed in its analyses than most published ecological risk assessments to date. It also included a more detailed analysis of uncertainties than most ecological risk assessments. The document was reviewed and approved by regional and national offices of DOE and EPA and by TDEC. Progress reports and conclusions were presented to the public on several occasions. The remedial investigation report, including the ecological risk assessment, was accepted by EPA and TDEC.

DOE, EPA, and TDEC are required by CERCLA to make decisions concerning risks to the environment and the best forms of risk management to deal with those risks. Weighing the risks of remedial activities against the risks from current exposures is necessary under CERCLA and is not forbidden by NEPA, so it was done as a part of the feasibility study. The approach to balancing risks, in which human health risks and risks to the environment were considered, was developed by a task force that included representatives from ATSDR, Environmental Quality Advisory Board, ORNL, and Science Applications International Corporation. The use of that method was approved by EPA and TDEC and has received general support from the public.

ISSUE 25: WETLANDS

Comment: Edmund Nephew, Mayor of the City of Oak Ridge, stated that the damage to wetland and riparian habitats accompanying remediation may be more damaging to the environment than the current exposures. He also expressed a concern that there is insufficient information on how wetlands disturbed by remedial activities would be restored, replaced, or compensated. He stated that preservation of wetlands is preferable to mitigation. (028789)

Response: The delineated wetlands at the NOAA site are no longer slated for excavation. Only 0.24 ha (0.6 acres) of the "low-quality" wetlands at the Bruner's Center site have mercury

concentrations >400 ppm. That portion of wetlands will be remediated and restored. No wetlands will be removed and compensated for on DOE property. The amount of riparian habitat to be disturbed is small.

ISSUE 26: ECOLOGICAL BIOAVAILABILITY TOO CONSERVATIVE

Comment: Fred Maienschein said that the assumption of 100 percent bioavailability was a fundamental flaw in the risk assessment. (PM38, PM40)

This point was reiterated by Alfred Brooks. (PM42)

Response: Exposure estimates in the ecological risk assessment were not based on the bioavailability information used to revise the human health remediation goal. Instead, bioaccumulation factors derived from site-specific data or from published information were used to estimate bioavailability of total mercury to plants and animals. It was assumed that 100 percent of methyl mercury in ingested food is bioavailable. That assumption is prudent because methyl mercury, unlike particle-bound or insoluble inorganic mercury species, is readily absorbed after it is ingested.

ISSUE 27: MERCURY SPECIATION

Comment: Ralph Hutchison, OREPA said, "Re-speciation by biota is noted but not fully explored in the ecological risk assessment. He said that DOE has not adequately explained the cyclical nature of mercury speciation in an anaerobic system in the presence of bacteria. He also said that EPA's Environmental Monitoring Systems Lab was unable to provide conclusive evidence that a high percentage of the mercury in the EFPC floodplain is in the form of mercury sulfide. (028835)

Comment: Sandra Reid asked about future projections of the mercuric sulfide in an anaerobic environment. (028786)

Comment: A card anonymously submitted at the public meeting asked how elemental mercury became mercuric sulfide and how many studies were conducted. (PM46)

Response: Mercury in Lower EFPC, as in all environments, is subject to transformations as a result of changing biogeochemical conditions. The biogeochemical cycle of mercury is tremendously complex. Since the 1970s, a voluminous amount of literature has been produced on many aspects of mercury biogeochemistry. Despite this effort, many fundamental questions

still remain, and will remain unanswered for the foreseeable future. The lack of a fundame..... understanding of many processes governing the behavior of mercury in the environment is not limited to Lower EFPC. Thus, it is not a reflection of a lack of scientific effort, but rather an indicator of the complexity and magnitude of the problem and the pace of science. Because some fundamental questions will remain independently, and because the environment in the floodplain will always be dynamic, the biogeochemistry of mercury in the Lower EFPC floodplain will never be understood unequivocally. To make a decision within the FFA milestones, we must rely on our current understanding of mercury in the Lower EFPC, based on DOE-sponsored investigations and on data available in the scientific literature, while maintaining awareness about subjects where knowledge is limited. The evidence must be weighted and criticality evaluated, as the speciation of mercury in Lower EFPC soils illustrates.

Revis, et al. (1989a), using a sequential extraction technique he developed (Revis, Osborne et al., 1989b), determined that mercury in several soils in the floodplain were approximately 85 percent mercuric sulfide. Subsequently, EPA EMSL, using a sequential extraction procedure they developed (Miller 1993), determined the mercury in a different set of soils from the floodplain was predominantly elemental mercury (Dobb Miller et al. 1994), though significant mercuric sulfide was detected in deeper, more concentrated samples. To resolve this discrepancy, ORNL-ESC compared the results of the Revis and EMSL sequential extraction procedures, as well as a third procedure (Sakamoto, Tomiyasu et al. 1992), on the same set of five soils. The results indicated the mean percentage of mercuric sulfide detected by the three procedures was 46 percent, 25 percent, and 83 percent, respectively (Barnett, Harris et al. in press). The biggest difference between the results for the Revis and EMSL procedures was in the abundance of elemental mercury, an average of 28 percent and 72 percent, respectively. Researchers from ORNL traveled to EMSL to discuss these issues, but no final resolution was reached. ORNL-ESD has several theories as to the causes, mostly related to the nature of sequential extraction methods and the procedures used for their development. Although sequential methods are common methods for speciating metals in soils and sediments (Tessier, Campbell et al. 1979), these results illustrate the problems of using sequential extraction procedures for quantitative analysis and are common concerns with sequential extraction procedures (Pickering 1981). All three techniques did indicate, however, the mercury in Lower EFPC soils was ~~not organic~~, was not water soluble, and was resistant to extraction except by aggressive means.

Other evidence implicated the presence of mercuric sulfide in Lower EFPC soils. A consistent association between elemental mercury and elemental sulfur was shown in a number of soils (K-25 Technical Division 1993). Total mercury correlated with total sulfur in the deeper samples from the floodplain (Barnett and Turner 1995). In addition, sub-micron crystals of mercuric sulfide (metacinnabar) were definitively identified in some soil fractions (DOE 1994c).

Although the evidence is not conclusive quantitatively, the weight of the evidence suggests there is mercuric sulfide in Lower EFPC soils. There is a clear association between mercury and sulfur in a larger number of soils and mercuric sulfide was detected in all three sequential extraction procedures applied to Lower EFPC soils, though the relative fractions were variable. We do not definitely know the percentage of mercuric sulfide throughout the floodplain, nor is the technology to determine this information available. In addition, as the mercury was not discharged to the Y-12 Plant as a sulfide, it must have formed in situ, which is geochemically intuitive and has been suggested in the scientific literature for years. This mercuric sulfide could not have come from coal-fired steam plant emissions, as the majority of mercury in smoke stacks is elemental, and there is no increase in mercury concentrations in noncontaminated soils in Oak Ridge nor in other locations adjacent to coal-fired steam plants.

The potential for inter-species transformation of mercury in the floodplain is not known precisely. This lack of knowledge is not just reflective of Lower EFPC, but of the global mercury cycle as a whole. Of particular importance to the Lower EFPC is the transformation from relatively innocuous mercuric sulfide to other more detrimental forms. While we do not completely understand the cycles or all the issues involved, the available data suggest mercuric sulfide is resistant to transformation. Over 1,000 times as much methylmercury formed in sediments dosed with mercuric chloride (basis for RfD) as compared to mercuric sulfide (Fagerstrom and Jernelov 1971). The mobilization of mercuric chloride from sediments to fish in aquariums was more rapid than the mobilization of mercuric sulfide (Gillespie and Scott 1971). The volatility of mercury from soils decreases with solubility, and is very low for mercuric sulfide (Rogers 1979). Mercuric sulfide (cinnabar) applied to soils even in high concentrations did not fail the TCLP test (Willet et al. 1992). Engler and Patrick (1975) studied the transformation of mercuric sulfide dosed soils, and detected little transformation in either aerobic or anaerobic conditions. Mercuric sulfide (cinnabar) was resistant to weathering in a riverwash soil (Harsh and Doner 1981). Metal sulfide oxidizing bacteria were not observed to oxidize mercuric sulfide (cinnabar) (Silver and Torma 1974).

While the methylation of mercury by microorganisms in anaerobic waters has been noted, the production of anaerobic conditions by sulfate-reducing bacteria should actually promote the formation of mercuric sulfide. Revis (1989a) shows an approximately 90 percent conversion of mercuric chloride to mercuric sulfide in anaerobic soils by anaerobic organisms within 30 days. One unknown piece of information, until recently, was the weathering rate of mercuric sulfide by oxidants common in the environment. Recent research at ORNL-ESD has shown the oxidation rate of mercuric sulfide to be slow, with half-lives ($t_{1/2}$) on the order of 20–200 years depending on the conditions. If the weathering rate is slow ($t_{1/2}$ of tens to hundreds of years) relative to the rates of formation ($t_{1/2}$ of days to months) as is suggested, mercury may be

effectively immobilized for long periods as mercuric sulfide. Indeed the current speciation in the Lower EFPC floodplain is the result of 30–40 years of such transformations. Research on this subject is ongoing.

Finally, the ecological and human health remediation goals are not based on the speciation results per se. There is not an accepted RfD for mercuric sulfide, and the mercury in the Lower EFPC soils is not 100 percent mercuric sulfide. The human health remediation goal was based on a bioavailability study (Barnett and Turner 1995) designed to measure the fraction of mercury in soil available for absorption in the human digestive tract due to soil ingestion, the critical pathway for human exposure in this system. This study, adopted from an EPA-approved protocol at another CERCLA site, measured site- and soil-specific bioavailability *without regards to speciation*. The bioavailability of mercury in Lower EFPC soil, regardless of form, was shown to be orders of magnitude less than mercuric chloride, the basis for the RfD. Similarly, the ecological risk assessment did not involve assumptions about mercury speciation. The mercury speciation studies provided insight into the behavior of mercury in Lower EFPC soils (i.e., the low solubility and bioavailability), but did not explicitly influence the RGO calculations. These issues are discussed in more detail in the Addendum to the remedial investigation (DOE 1994c).

ISSUE 28: SUGGESTIONS FOR THE SELECTED REMEDY

Some people suggested technologies or ideas that might be considered.

Comment: Fred Hannon challenged the audience to develop their own alternative because few members seemed to support the DOE preferred alternative. (PM18)

Comment: Ralph Hutchison, OREPA, suggested that DOE limit access and maintain strict environmental controls on EFPC pending any further action and that DOE purchase, at fair market value, lands in the EFPC floodplain to limit access, restrict development, and guarantee cleanup. He suggested that lands could be sold back to owners at fair market value if remediation efforts are successful. (028835)

Comment: Ellen Smith, Environmental Quality Advisory Board, suggested that DOE offer to buy the affected land at a fair market value or to purchase deed restrictions that would prohibit certain uses on affected portions of the land. Following remedial action, the land could be transferred to the city of Oak Ridge or the state of Tennessee for floodplain protection and other compatible public uses. (028767)

Comment: Fred Sweeton said he thinks each landowner affected by the remediation effort "should be paid an amount equivalent to a reasonable rent up to the present time, and in addition each should be offered a payment to compensate for both the real and the perceived impairment of their land for future use." (028768)

Comment: Robin Williams suggested mixing the topsoil to a depth of about 6 in. using a disk harrow for areas that have surface contamination slightly higher than acceptable levels. He suggested burying the topsoil under 18 in. of subsoil for those areas where this will not adequately reduce the level of contamination. (028747)

Comment: Daniel Axelrod recommended four additional alternatives: (1) delay action for 10 years, then reassess; (2) divert headwaters of EFPC to the headwaters of Bear Creek, (3) doing the maximum amount of remediation possible for $4.5 million; and (4) doing the maximum amount of remediation possible for $10 million. (028748)

Comment: Charles and Alma Schmitt said DOE should consider installing emergency cleanup treatment measures at Y-12 (holding pond, bags of Imbiber Beads for PCBs and oils, ion exchange resins, and activated carbon granules) to adsorb pollutants before they reach the city of Oak Ridge. (028448)

Comment: J. Francis suggested installing some sluice boxes to collect any mercury migrating downstream and allowing the stream to clean itself. (028759)

Comment: Sara Childs asked, "How will the public be informed if the preferred alternative is changed." She also asked, "Where are the areas of highest bioavailability?" (PM29, PM47)

Comment: Ardis Leichsenring wrote, "We can see no reason for having all the areas of the EFPC floodplain treated in the same way. The contamination levels are different and future uses vary considerably." (028258)

Comment: Alfred Brooks reiterated what Leichsenring said. (PM32)

Response: DOE appreciates the suggestions offered through written comments and at the public meeting. Some suggestions are detailed enough that they would not affect the outcome of the remedy selection process. Those suggestions will be taken into consideration during the detailed design phase of the remedial action.

DOE has determined that the purchase of private properties in the Lower EFPC floodplain would not provide the degree of protectiveness achievable through excavation and disposal of the soil contaminated with > 400 ppm mercury, may be difficult to implement, and would be an unnecessary expenditure of public funds. Excavation and disposal has been chosen in favor of long-term institutional controls (e.g., access restrictions and deed restrictions) to avoid requiring DOE to maintain long-term control of personal property and to provide for a permanent remediation.

Mixing contaminated topsoil to a depth of 6 in. would essentially dilute the concentration of mercury in the floodplain soil. While this would decrease the maximum concentrations of mercury in the soil, it would not decrease the amount of total mercury in the floodplain, and it may increase the volume of contaminated soil. Burying the topsoil under 18 in. of subsoil essentially constitutes a cap. Capping is generically referred to as containment in the proposed plan and was considered as a component of Alternatives 2, 4, and 6. The excavation and disposal alternative rated higher than containment alternatives in the evaluation of alternatives because it provides better long-term effectiveness and permanence.

Delaying action for 10 years would potentially nullify the current characterization of the floodplain soils. Reassessing the site in 10 years could require duplicating the remedial investigation efforts already conducted, resulting in an unnecessary expenditure of public funds.

Diverting the headwaters of EFPC to Bear Creek would decrease the volume of water flowing through the Lower EFPC floodplain, but it would not decrease the amount of mercury now present in the floodplain soil.

The lowest-cost alternative evaluated, the no action alternative, is estimated to cost $12 million dollars. Therefore, no evaluated remedial alternative would be possible for $4.5 million or $10 million.

The amount of mercury discharged from Y-12 into Lower EFPC is already very low and is continually decreasing. Installing emergency cleanup treatment measures at the Y-12 Plant would not affect the amount of mercury currently present in the Lower EFPC floodplain soil.

Sluice boxes would not be effective in collecting mercury suspended in the surface water. Other methods of capturing the mercury may be considered during remedial design.

A public information meeting is planned. At the meeting, DOE will present the most current information about the site and the selected remedy. The meeting will be announced in local newspapers well in advance of the meeting date.

Current land uses in the floodplain vary considerably. However, one goal of the Lower EFPC soil remediation is to allow for future unrestricted land use. The most conservative land use is the residential land use scenario. To allow for all types of future land use, all areas of the Lower EFPC floodplain will be treated in the same way (i.e., all areas of the floodplain soil with mercury concentrations > 400 ppm will be excavated). The area of higher bioavailability is near the Y-12 Plant at the NOAA site.

ISSUE 29: ATSDR HEALTH CONSULTATION

Comment: Amy Fitzgerald, ORR Local Oversight Committee, said that without additional information, the ATSDR may not be able to "sign off" on a significantly higher cleanup level. (028769)

Comment: Max Howie, Jr., ATSDR, submitted a draft report stating that the proposed remediation goal of 180 ppm mercury was protective of human health. (028592)

Comment: The Oak Ridge City Council and Environmental Quality Advisory Board requested that the ATSDR conduct another independent evaluation if the remediation goal is increased. (028789, 028767)

Comment: A card submitted anonymously at the public meeting asked what kind of health evaluation was done to show the remediation goal of 180 ppm was safe. (PM48)

Comment: Alfred Brooks asked if ATSDR could comment if a remediation goal is "overly safe." (PM50)

Response: At the request of private citizens, ATSDR has conducted two health consultations. The first consultation evaluated public health issues related to the current contamination in EFPC. ATSDR concluded that soil mercury levels in some locations along EFPC pose a threat to public health, especially to children who play in the creek's floodplain. In addition, ATSDR stated contaminants in the shallow groundwater are of public health concern, but the groundwater is not used for drinking water or other domestic purposes and does not pose

a threat to people who receive drinking water from the municipal water supply. ATSDR also concluded that frequent ingestion of fish from the creek over a prolonged period poses a moderate increased risk of adverse health effects.

The second consultation evaluated DOE's remediation goal of 180 ppm mercury in the EFPC floodplain soil. ATSDR concluded the remediation goal was protective of public health. Based on comments made during the EFPC public meeting, ATSDR initiated an addendum to the consultation to evaluate the new remediation goal of 400 ppm. ATSDR has determined that the 400 ppm mercury remediation goal for the EFPC floodplain soil to be protective of public health. ATSDR does not determine if a remediation goal is "overly safe."

ISSUE 30: PROJECT COSTS

Some people questioned specific project costs.

Comment: Fritz McDuffie asked how much money had been spent by all of the parties concerned on this project without any remediation being done yet. (PM09)

Comment: Sara Childs asked if money is already set aside for this project. If not, she asked how DOE budget cuts would affect this project. (PM11)

Response: As of January 1995, DOE has spent $24.7 million on the Lower EFPC CERCLA project.

DOE conducts a prioritization of all projects based on risk to human health and the environment. Because DOE-operations-related contamination has migrated off of the controlled area of the ORR, this program will continue to rate very high in remediation activities.

ISSUE 31: PROPER INVESTIGATIVE PROCESS NOT FOLLOWED

Several people questioned the procedures followed during the remedial investigation and the risk assessment.

Comment: James Phelps wrote, "The proper process for doing this study is to map all the pollution as it sits currently, via environmental sampling. Next, to fully determine the specification [sic] of the many representative areas of the mercury pollution and also to consider if other forms of pollution are present. Next, to look at all known emissions to the Creek and Floodplain to determine the equations in time for how the pollution deposits are changing in time

and spatial redistribution. Finally, to clearly present all known information accurately and farely [sic] to the public which is clearly involved and has the right to the full information set. To my knowledge DOE has only reached step number one above." (028742)

Comment: Sandra Reid wrote that "good science" was not employed and that the analysis is not accurate and "does not deal with the complexity of human beings and their varied responses to toxic assaults." (028786)

Comment: Elizabeth Peelle asked if the risk assessment procedure described by Mr. Zafran of Science Applications International Corporation was the standard practice for conducting risk assessments. (PM27)

Response: Since the ORR was formally placed on the National Priorities List of CERCLA in December 1989, DOE has followed CERCLA guidance. In addition DOE has complied with the provisions of the FFA in all aspects of the Lower EFPC project. In particular, during the remedial investigation and baseline risk assessment for Lower EFPC, DOE obtained regulatory approval of the technical approach to be used in collecting data for the project and advice and assistance from an EPA national laboratory.

DOE conducted all four steps outlined in Mr. Phelps' comment. A two-phased approach was followed in the remedial investigation stage. DOE identified and tested for 182 potential contaminants and performed a screening level risk assessment on the results. After it was determined that mercury was the primary contaminant of concern, the extent of this and some other metals were determined by a systematic sampling of the entire floodplain of the creek, involving over 3,000 samples. Since mercury proved to be the contaminant contributing by far the greatest potential risk, and because the human health risk assessment process DOE was required to use is especially sensitive to the species or form of mercury, special studies were pursued to determine the various species of mercury in floodplain soils.

During these investigations it was shown that areas identified in the early 1980s as high in mercury are still high and areas that are low were still low suggesting that the mercury has some stability in the floodplain. Also, it was shown that many areas having higher mercury concentrations were buried under soils deposited since the mercury releases in the late 1950s and early 1960s. Studies were also performed which showed that sloughing of creek banks containing high mercury concentrations could be accurately modelled (model results matched field measurements).

DOE has made the information on this and other environmental restoration projects available to the public as soon as possible and has specifically staffed an Information Resource Center where the public can easily obtain this information free of charge. Further discussion of community outreach is contained in the response to comments for Issue 39 (Citizen's Working Group) and in the Decision Summary of the ROD.

The human health risk assessment process follows the standard EPA protocols for this work. For the Lower EFPC project, extra care was taken to identify the uncertainties in the risk assessment process.

ISSUE 32: GROUNDWATER RISKS

Comment: Amy Fitzgerald, ORR Local Oversight Committee, said she thinks DOE should "commit in writing to the city and other property owners that the agency will address, and is liable for groundwater contamination." (028769)

Comment: Ellen Smith, Environmental Quality Advisory Board, said she thinks that nothing needs to be done to address groundwater contamination. She said she understands that "unacceptable" levels of contaminants were found in unfiltered samples of floodplain groundwater but not in filtered samples, indicating that the measured contamination was in soil particles suspended in the water. She said that domestic water supply wells and delivery systems are designed and built to exclude suspended sediment, so people would not drink the suspended contaminants. (028767)

Response: DOE is committed to monitoring groundwater and performing periodic use surveys to determine if EFPC groundwater aquifers are being used as potable sources. Mitigative action would be taken if required.

Domestic drinking water supplies are not always filtered, so it is possible that people would ingest suspended contaminants. For this reason, EPA protocol specifies that the presence or absence of groundwater contamination be determined through analysis of unfiltered samples. *Risk Assessment Guidance for Superfund, Volume 1* (EPA 1989) states, "...While filtration of groundwater samples provides useful information for understanding chemical transport within an aquifer, the use of filtered samples for estimating exposure is very controversial because these data may underestimate chemical concentrations in water from an unfiltered tap. Therefore, data from unfiltered samples should be used to estimate exposure concentrations..."

ISSUE 33: MERCURY EFFECTS ON HUMANS

Two people asked if DOE would be interested in results of studies showing effects of mercury on humans.

Comment: Alfred Brooks said there was some work done in Singapore because Chinese traditional medicine prescribes cinnabar, which is mercuric sulfide, to calm people's nerves. He also mentioned a reference by Goyer on human gut absorption of inorganic salts, a reference by Frieberg on oral toxicity in humans, and a reference by Sin on human relative uptake of chloride and sulfide in the spleen and the liver. In addition, he cited an Oak Ridge study on mice. (PM14, PM25)

Comment: Harry Francke asked if DOE would be interested in knowing about people who are now suffering from mercury poisoning. (PM23)

Response: DOE recognizes that there is a great deal of uncertainty about the toxicity of mercury. EPA has withdrawn the reference dose from its Integrated Risk Information System because of that uncertainty. The document submitted to EPA requesting approval of a reference dose for mercuric sulfide included some of the references offered by Mr. Brooks. In particular, the reference by Sin on absorption of mercuric sulfide and references on use of mercury-containing compounds as medications were used in that document. The other references Mr. Brooks called to DOE's attention were used and cited in the human health risk assessment portion of the remedial investigation report. They add weight to the conclusion that the selected remedy will be conservatively protective of human health.

Mr. Francke and others have stated that there are people suffering from the toxic effects of mercury exposure in the EFPC floodplain. In several public meetings, DOE has expressed its interest in talking to or knowing the names of such individuals. To date, no affected individuals have come forward or been identified by name. Any exposures that may have occurred at other sources, such as the Clinch River, tributaries beyond the influence of EFPC, or the work place, are not the subject of this remedial action, but DOE would be happy to talk to people who are concerned that they may have been affected.

ISSUE 34: CITIZENS' WORKING GROUP

Several people discussed the Citizens' Working Group.

Comment: Ellen Smith said that DOE's efforts to involve and inform the community about the site and the remedial investigation/feasibility study process have been exemplary, with the exception of the CERCLA/NEPA integration issue previously discussed. (028767)

Comment: Sara Childs asked for information concerning the existence of a citizens advisory board mentioned during the public meeting. (PM43)

Comment: Sandra Reid said that the Citizens' Working Group was "an obvious ploy to make it appear that the concerns of the community were being addressed, while keeping a tight rein on the meetings." She said there was no outreach to Scarboro or to other impacted stakeholders and that newcomers were prevented from joining. She said the majority of the participants were Martin Marietta Energy Systems, Inc., employees and wrote, "one has to question whether or not they could speak out, a difficult conflict." She concluded that the Citizens' Working Group was used to "imply consensus, agreement, and consent with the process. That is not a true representation of all views." (028786)

Comment: Concerning the Citizens' Working Group, Ralph Hutchison wrote, "DOE misrepresents public opinion in the Feasibility Study. In the most egregious example, the document claims...that the EFPC [community?] recommended a cleanup level of 200 ppm. DOE does not explain the methodology used to elicit this recommendation, implying only that the Citizens' Working Group provided a consensus recommendation. The implication is entirely false; from the outset, at least one member of the Working Group was steadfast in refusal to accept an arbitrarily established cleanup level based on a mercury sulfide theory. The shortcomings of the Working Group process aside (they were legion), DOE at least owes the public an accurate and fair presentation of the results of the Working Group process." (028835)

Response: The Lower EFPC Citizens' Working Group was established in May 1993 to provide the opportunity for members of the community to interact with members of the project team and provide input on the development of cleanup alternatives. From the beginning, DOE explained that the group was neither a decision-making nor consensus-building body, and that DOE had the legal obligation of recommending the preferred remedial alternative.

The group met monthly for more than a year. Each meeting was open to the public and members of the media were invited to report on each meeting.

While there were members who believed the cleanup levels should be lowered and/or studied further, the majority of the group expressed opinions that the levels were too low, based on the form of mercury believed to be in the floodplain, and requested that DOE conduct speciation studies to confirm that belief.

ISSUE 35: PROPOSED PLAN DIFFICULT TO UNDERSTAND

Comment: Herman Weeren wrote that the proposed plan was difficult to read and understand. (028563)

Response: To clearly and concisely summarize the feasibility study (DOE 1994b) and present DOE's preferred alternative, the proposed plan (DOE 1995b) was published in a fact sheet format. Many complex issues were summarized in the 10-page document. Engineers and scientists first wrote the plan, then professional editors revised it to make it readily understandable to the general public. DOE personnel are available to explain any difficult concepts to members of the public.

REFERENCES

Barbour, M. G., J. H. Burk, and W. D. Pitts. 1980. *Terrestrial Plant Ecology*, The Benjamin/Cummings Publishing Company, Inc.

Barnett, M. O., L. A. Harris, R. R. Turner, T. J. Henson, R. E. Melton, and R. J. Stevenson. in press. "Characterization of mercury species in contaminated floodplain soils." Water, Air, and Soil Pollution.

Barnett, M.O. and R. R. Turner. 1995 (in press). *Bioavailability of Mercury in East Fork Poplar Creek Soils*. Y-12 ER Report.

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Interim Final*. OSWER Directive 9285.7-01a, EPA-540/1-89-002. December.

Dobb, D., E. Miller, D. Cardenas, and K. Brown. 1994. *Determination of Mercury, with Speciation, in Poplar Creek Soil Samples*. Environmental Protection Agency, Environmental Monitoring Systems Laboratory. Internal Report. Las Vegas, NV.

DOE (U.S. Department of Energy). 1992. *Federal Facility Agreement for the Oak Ridge Reservation*. DOE/OR-1014, U.S. Environmental Protection Agency Region IV, Atlanta, GA, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, TN, and Tennessee Department of Environment and Conservation, Nashville, TN. January 1.

DOE. 1993. *Treatability Study Report for Mercury in East Fork Poplar Creek, Oak Ridge, Tennessee*, Prepared for U.S. DOE by Radian Corporation under Contract DE-AC05-90OR21851. September.

DOE. 1994a. *East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report*. DOE/OR/02-1119&D2. Prepared for U.S. DOE by Science Applications International Corporation (SAIC), Oak Ridge, TN under Contract No. DE-AC05-91OR21950.

DOE. 1994b. *Feasibility Study for the Lower East Fork Poplar Creek—Sewer Line Beltway*. DOE/OR/02-1185&D2. Volumes 1 and 2. Prepared for U.S. DOE by Science Applications International Corporation (SAIC), Oak Ridge, TN under Contract No. DE-AC05-91OR21950.

DOE. 1994c. *Addendum to the East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report*. DOE/OR/02-1119&D2/A1/R1. Prepared for U.S. DOE by Science Applications International Corporation (SAIC), Oak Ridge, TN.

DOE. 1995a. *Remedial Goal Options for Mercury in Sediment of East Fork Poplar Creek, Oak Ridge, Tennessee*. DOE/OR/01-1342&D2. Prepared for U.S. DOE by Science Applications International Corporation (SAIC), Oak Ridge, TN.

DOE. 1995b. *Proposed Plan, East Fork Poplar Creek—Sewer Line Beltway, Oak Ridge, Tennessee*. DOE/OR/02-1209&D3.

Engler, R. M. and W. H. Patrick. 1975. "Stability of Sulfides of Manganese, Iron, Zinc, Copper, and Mercury in Flooded and Nonflooded Soil." Soil Science. 119(3):217-221.

Fargerstrom, T. and A. Jernelov. 1971. "Formation of Methyl Mercury from Pure Mercuric Sulphide in Aerobic Organic Sediment." Water Research. 5: 121-122.

Gillespie, D. C. and D. P. Scott. 1971. "Mobilization of Mercuric Sulfide from Sediment into Fish under Aerobic Conditions." Journal of the Fisheries Research Board of Canada. 28(11): 1807-1808.

Harsh, J. B. and H. E. Doner. 1981. "Characterization of mercury in a riverwash soil." Journal of Environmental Quality. 10(3):333-337.

Hildebrand, S., J. Huckabee, F. Diaz, S. Janzen, J. Solomon, and K. Kumar. 1980. *Distribution of Mercury in the Environment at Almaden, Spain.* ORNL/TM-7446, Oak Ridge, Tennessee.

Hinzman, R. L. (Ed.). 1993. *Second Report on the Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek.* Y/TS-888. Oak Ridge National Laboratory, Oak Ridge, TN.

K-25 Technical Division. 1993. *East Fork Poplar Creek Soils Investigation of Mercury Form and Association.* Internal Report No. Y/ER-67. Martin Marietta Energy Systems, Inc. Oak Ridge, TN.

LaGrega, M. D., P. L. Buckingham, and J. C. Evans. 1994. *Hazardous Waste Management,* McGraw-Hill, Inc., New York.

Miller, E. L. 1993. *Speciation of Mercury in Soil.* Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, NV.

Pickering, W. F. 1981. "Selective chemical extraction of soil components and bound metal species." CRC Critical Reviews in Analytical Chemistry. 2:233-266.

Revis, N. W., T. R. Osborne, G. Holdsworth, and C. Hadden. 1989a. "Distribution of mercury species in soil from a mercury-contaminated site." Water, Air, and Soil Pollution. 45:105-113.

Revis, N. W., T. R. Osborne, D. Sedgley, and A. King. 1989b. "Quantitative method for determining the concentration of mercury(II) sulphide in soils and sediments." Analyst. 114:823-825.

Rogers, R. D. 1979. "Volatility of mercury from soils amended with various mercury compounds." Soil Science of America Journal. 43:289-291.

Rowley, D. L., P. Turri, and D. C. Paschal. 1985. "A Pilot Study of Mercury Levels in Oak Ridge, Tennessee" Centers for Disease Control, Atlanta. October.

Sakamoto, H., T. Tomiyasu, and N. Yonehara. 1992. "Differential determination of organic mercury, mercury(II) oxide and mercury(II) sulfide in sediments by cold vapor atomic absorption spectrometry." Analytical Sciences 8:35-39.

Silver, M. and A. E. Torma. 1974. "Oxidation of metal sulfides by Thiobacillus ferrooxidans grown on different substrates." Canadian Journal of Microbiology. 20:141-147.

Suter, G.W. II, B.E. Sample, D.S. Jones, and T.L. Ashwood. 1994. *Approach and Strategy for Performing Ecological Risk Assessments for the U.S. Department of Energy's Oak Ridge Revision: 1994 Revision.* ORNL ES/ER/TM-33/RI.

Tessier, A., P. G. C. Campbell, and M. Bisson. 1979. "Sequential extraction procedure for the speciation of particulate trace metals." Analytical Chemistry. 51(7):844-851.

University of Michigan. 1987. "Health Evaluation of Y-12 Workers Formerly Exposed to Mercury" April 30.

Willet, K. L., R. R. Turner, and J. J. Beauchamp. 1992. "Effect of chemical form of mercury on the performance of dosed soils in standard leaching protocols: EP and TCLP." Hazardous Waste and Hazardous Materials. 9(3):275-286.

APPENDIX A

COMMENTOR/COMMENT CODE/ISSUE CROSS-REFERENCE

Name	Comment Code	Issues
W. W. Parkinson	028226	17
Ardis Leichsenring	028258	3,28
Helen Waraksa	028308	3
James Ed Westcott	028318	3,6,24
Richard & Jane Hicks	028345	1,5,13
Ann & Douglas Macdonald	028346	1,3,24
Alfred Brooks	028347	1,4,24
Murray Rosenthal	028416	1,6
Michael Finn	028421	3,5
Sidney du Mont III	028439	5,10,11
C. R. & A. P. Schmitt	028448	3,5,6,14,28
John & Kathleen Shacter	028453	1,18
Herman Weeren	028563	1,5,35
Fred Maienschein	028564	1,5,24
Alfred Brooks	028591	1,14
Max Howie, Jr. (ATSDR)	028592	29
James Harless	028621	8
William Fulkerson (FOORNL)	028650	1,6
Geoffrey Gleason	028673	3,6,24
Alfred Brooks (13-person petition)	028674	1,13,14
James Johnson, Jr.	028675	1,5
Melvin Sturm	028732	8,16
James Phelps	028742	4,24,31
William Wilcox, Jr.	028744	1,4,6
Jane Shelton	028745	1
Linda Ewald	028746	4,10,11
Robin Williams	028747	28
Daniel Axelrod	028748	3,17,28
L. Francis	028759	3,28

Name	Comment Code	Issues
G. Wayne Clark	028766	8,16
Ellen Smith (EQAB)	028767	1,9,19,24,28,29,32,34
Fred Sweeton	028768	1,6,24,28
Amy Fitzgerald (ORR LOC)	028769	8,14,29,32
Sandra Lock Reid	028786	2,4,7,27,31,34
Robert Peelle	028788	1,14
Edmund Nephew (City of Oak Ridge)	028789	1,8,9,16,25,29
A. D. Ryon	028820	1,24
Elizabeth Busteed	028834	3,6
Ralph Hutchison (OREPA)	028835	2,4,7,9,24,27,28,34
Fred Maienschein	PM01	1,6
Al Brooks	PM02	1,4,13
Ellen Smith (EQAB)	PM03	1,6,9
Herman Weeren	PM04	5
Patty Dyer	PM05	5
John Williams	PM06	22
Robert Peelle	PM07	1,8,14
Ardis Leichensring	PM08	10,15
Fritz McDuffie	PM09	6,30
William Wilcox	PM10	1,4
Sarah Childs	PM11	30
Harry Francke	PM12	11
Bill Burch	PM13	23
Al Brooks	PM14	33
Wayne Clark	PM15	21
William Wilcox	PM16	4
Ricky Williams	PM17	9,11
Fred Hannon	PM18	5,28
Fred Maienschein	PM19	1

Name	Comment Code	Issues
Jon Johnston (FOORNL)	PM20	1
Elizabeth Peelle	PM21	5,9
Sarah Childs	PM22	5
Harry Francke	PM23	33
Vickie Brumback	PM24	20
Al Brooks	PM25	33
Herman Weeren	PM26	7
Elizabeth Peelle	PM27	31
Shannon Gorman	PM28	12
Sarah Childs	PM29	28
John Williams	PM30	7
Ray Hedrick	PM31	18
Al Brooks	PM32	1,28
Card #1[a]	PM33	6
Al Brooks	PM34	4
Card #2	PM35	5
Card #3	PM36	5
Card #4	PM37	5
Fred Maienschein	PM38	26
Al Brooks	PM39	1
Fred Maienschein	PM40	26
Elizabeth Peelle	PM41	9
Al Brooks	PM42	26
Sarah Childs	PM43	34
Card #5	PM44	10
Card #6	PM45	7
Card #7	PM46	27
Sarah Childs	PM47	28
Card #8	PM48	29

Name	Comment Code	Issues
Card #9	PM49	7
Al Brooks	PM50	

[a]Cards refer to comments anonymously submitted at the public meeting.

ATSDR = Agency for Toxic Substances and Disease Registry
EQAB = Environmental Quality Advisory Board
FOORNL = Friends of Oak Ridge National Laboratory
OREPA = Oak Ridge Environmental Peace Alliance
ORR LOC = Oak Ridge Reservation Local Oversight Committee